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METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 15

APRIL 1948

Part 8

I.—PROPERTIES OF METALS

***Thermal Conductivity of Aluminium; Solid and Liquid States.** C. C. Bidwell and C. L. Hogan (*J. Appl. Physics*, 1947, **18**, (8), 776-779).—Thermal conductivity measurements were made with aluminium of commercial purity (99.2%) and with 99.95%-pure metal. A modified Forbes-bar method was used; the apparatus and experimental principles are fully described. Results obtained were:

	25° C.	240° C.	245° C.	250° C.	450° C.	590° C.	650° C.	740° C.	900° C.
99.2% Al	0.500	...	0.457	...	0.414	0.365
99.95% Al	0.538	0.486	...	0.486	0.456	...	0.445	0.143	0.180

The purer sample has a higher conductivity at all temp.; the rate of decrease of conductivity with temp. is approx. equal for both samples. The results may be expressed by the relation $k/\rho C = K(1/T) + K'$, where C is the atomic heat, ρ is the density, and K and K' are constants. The intercept K' is the same for both solid and liquid phases. In connection with experiments on liquid aluminium, the conductivity of graphite was determined as 0.30 at 25° C., and 0.123 at 700° C.—G. V. R.

***Thermal Hardening of Cadmium Crystals.** C. L. Smith (*Nature*, 1947, **60**, (4066), 466-467).—Single crystals of cadmium show appreciable hardening (increase of yield stress by 5% over previously determined yield stress) in times as short as 4-5 min. at room temp. The time of annealing (20°-100° C.) to produce a given degree of thermal hardening decreases by a factor between 2 and 3 for every 10° C. rise in temp., and is a maximum for crystals where the angle between the direction of applied stress and the glide direction is between 30° and 50°. The required period of annealing also increases rapidly with the amount of pre-strain imposed on the crystal. The magnitude of the thermal hardening after heating at 200° C. for 30 min. and cooling to room temp. is a minimum and approx. zero for crystals with the glide direction at 40°-45° to the axis of the wire. The results are discussed. All the effects except the dependence on orientation are explicable by the movement of dislocations out of the crystal, or into positions where they cannot easily be moved by the applied stress.—G. V. R.

***The Adiabatic Temperature Changes Accompanying the Magnetization of Cobalt in Low and Moderate Fields.** L. F. Bates and A. S. Edmondson (*Proc. Phys. Soc.*, 1947, **59**, (3), 329-343).—The technique of measuring small thermal changes associated with the step-by-step changes in the magnetization of ferromagnetic materials in fields not exceeding a few hundred oersteds is described, together with detailed results for annealed and unannealed cobalt in the form of a stout wire. Graphs of the energy changes (thermal and magnetic) against the intensity of magnetization are given for three hysteresis cycles, and the data are tabulated. Cobalt behaves differently from iron and nickel, in that there is always an initial warming such that the max. rise of temp. occurs in the field change from $-H_m$ to $+H_c$, instead of an initial cooling such that the max. fall of temp. occurs in the interval of field change

* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.

from $-H_m$ to $-H_c$. The results are fully discussed on the basis of modern ferromagnetic theory and crystal-structure differences, though a note added to the paper suggests that, except for slight evidence of preferred orientation in the unannealed specimen, both of the specimens were closely similar in crystal structure.—G. V. R.

***High-Speed Compression Tests on Copper.** M. Greenfield and E. T. Habili (*J. Appl. Physics*, 1947, **18**, (7), 645–650).—An apparatus is described which permits dynamic shortening of $\frac{1}{2}$ -in.-long copper cylinders at an average strain rate of 1200/sec. The specimen is held against a hardened-steel anvil, and rapidly compressed by means of a steel projectile fired at it by means of compressed air. Details of the firing mechanism, which automatically controls the measuring devices, are given. The velocities of the projectile before and after impact are electrically recorded by means of an oscillograph, enabling the energy dissipated in compressing the specimen to be calculated. The strain rate is similarly computed from the velocity data. Results are shown as stress-strain curves, in which true stress and logarithmic strain are plotted, and are compared with results obtained in "static" tests at a strain rate of 1.5×10^{-3} /sec. The stress required to produce a given compressional strain dynamically is always greater than that required to produce the same strain statically, the percentage difference ranging from 17 to 29% for the interval of strain from 0.10 to 0.30. Comparison with data obtained in tension, at a strain rate of 900/sec. and in static testing, shows that similar behaviour is observed.—G. V. R.

***Activation of Copper by Oxidation and Reduction.** F. C. Aldred and F. Happey (*Nature*, 1947, **160**, (4060), 267–268).—Referring to work by Garner and Stone (*Nature*, 1946, **158**, (4025), 909; *Met. Abs.*, 1947, **14**, 89), X-ray experiments on the changes produced in metallic and oxide films of copper during the activation process are described. Unactivated bright copper sheet has finely divided orientated crystals and the diffraction patterns show faint oxide reflections. After oxidation in air at 850° C. (5 min.) the remaining copper has recrystallized into a macro-crystalline form with destruction of the orientation, and the oxide phase is in the form of a finely divided powder of CuO and Cu_2O . After reduction in hydrogen at 250° C. (1 hr.), the resulting copper is in two forms, one finely divided and the other as micro-crystals. The mechanism of the activation process is discussed in the light of these results. The oxide film formed cracks up and produces small crystals, so that there is always a possibility of oxygen reaching the copper surface. During reduction in hydrogen, the heat generated is rapidly removed from the reaction zone, and large-crystal formation is prevented. The structure is thus more spongy than when carbon monoxide is used, since the relatively low conductivity of this gas enables the heat liberated to cause recrystallization of the copper into a compact structure. This accounts for the specific effects of hydrogen in producing activated copper.—G. V. R.

***A Note on the Effect at the Cathode of an Arc Between Copper Electrodes.** Maurice Milbourn (*Proc. Phys. Soc.*, 1947, **59**, (2), 273–275).—Direct observation of burning arcs between copper and copper alloy electrodes, and microscopic examination of arced electrodes, show that at the cathode melting of metal does not necessarily occur. For cathodes of pure copper, cuprous oxide is formed. This may melt, and is the medium through which volatilization of copper is effected. Selective distillation of the impurities in the cathode does not occur to any marked extent under these conditions. In the presence of a powerfully reducing metal, as shown by observations on copper-rich copper-aluminium cathodes, considerable melting of the metal may occur, and the formation of cuprous oxide is hindered. Under these conditions, impurities distill preferentially. The bearing of these results on the spectrographic analysis of copper is briefly described.—G. V. R.

***The Kinetics of the Reaction Between Copper and Iodine in Various Solutions.** II.—Solutions of Iodine in Organic Solvents. L. L. Bircumshaw and M. H. Everdell (*J. Chem. Soc.*, 1947, (Sep.), 1119–1128).—Strips of thick copper foil were rotated in the appropriate iodine/organic solvent solution at about 100 r.p.m., and the course of the reaction followed by titration. Tests on five solutions of iodine in carbon tetrachloride ($N/400 - N/25$) at 25°C . showed the reaction to be proportional to the iodine concentration and inversely proportional to the thickness of the whitish-brown cuprous iodide film, i.e. if a = initial iodine concentration and $a - x$ = iodine concentration at time t , $dx/dt = k(a - x)/x$. At 25°C . the reaction rates in carbon tetrachloride and chloroform were practically identical; for concentrations greater than and including $N/100$ the rate of reaction in benzene was less than that in carbon tetrachloride, but it was slightly greater in $N/200$ and $N/400$ iodine solutions in benzene, and in diamyl ether the rate was much less than in carbon tetrachloride. Studies of carbon tetrachloride and chloroform solutions at 0° , 25° , and 30°C . showed that the temp. coeff. was very small. Carborundum straight-polished, carborundum circular-polished, jewellers'-roughed, and acid-etched surfaces produced only slightly different reaction rates in benzene at 25°C . The presence of an oxide film appreciably reduced the reaction rate in both benzene and carbon tetrachloride.—H. A. H.

***Absorption Bands of Li_2 , Na_2 , K_2 , and NaK .** R. W. B. Pearse and S. P. Sinha (*Nature*, 1947, 160, (4057), 159).—Investigations of the ultra-violet spectra in absorption of Li_2 , Na_2 , K_2 , and NaK are briefly reported. The Li_2 bands between $\lambda = 3500$ and $\lambda = 3100 \text{ \AA}$ belong to a single system, and not to four systems, as reported by Vance and Huffman (*Phys. Rev.*, 1935, 47, 215). The Na_2 bands between $\lambda = 3600$ and $\lambda = 3200 \text{ \AA}$ also belong to a single system. For K_2 two systems have been recognized; one lies between $\lambda = 4520$ and $\lambda = 4200$, and the other between $\lambda = 4160$ and $\lambda = 3940 \text{ \AA}$. One system has been recognized for NaK , the bands lying between $\lambda = 4080$ and $\lambda = 3820 \text{ \AA}$.—G. V. R.

***Effect of Bending on Selenium-Rectifier Disks.** P. Selényi and Nicholas Székely (*Nature*, 1947, 160, (4058), 197).—Bending a selenium-rectifier disc causes a temporary increase of the current flowing through it. Current values in the forward direction may increase by 5–10%, but a momentary increase of the current intensity up to 300% may be observed in the reverse direction. For the reverse direction, the stronger the bending the greater the max. effect, which is temporary and decays rapidly. At 50°C . the effect is smaller, and decays more rapidly, than at room temp. At small voltages (1–2 V.) no effect is observable; with increasing voltage it increases rapidly and reaches a maximum at 15–20 V. The effect is discussed, and attributed to transition of electrons into the conductivity levels under the influence of electrical and mechanical energy.—G. V. R.

***A Silicon-Metal Contact Resistance.** E. H. Putley (*Nature*, 1947, 160, (4073), 710–711).—In connection with work on silicon rectifiers the electrical contact resistance for a silicon crystal soldered to a brass pin was measured, and found to be small (1 ohm), but not negligible. The influence of the result on determinations of the "spreading resistance" for silicon, and also for germanium, rectifiers is discussed.—G. V. R.

***Ultra-Violet Bands of Na_2 .** S. P. Sinha (*Proc. Phys. Soc.*, 1947, 59, (4), 10–621).—The ultra-violet bands of Na_2 were studied in absorption and emission. In absorption, photographs were obtained from $\lambda = 3640$ to 500 \AA , and the results are tabulated. Seven different systems are recognized, three of which are strongly developed. Emission bands were observed only in the regions $\lambda = 3370\text{--}3180 \text{ \AA}$ and $\lambda = 3070\text{--}2960 \text{ \AA}$, corresponding to two of the strongest bands in the absorption spectrum. Vibrational

schemes for the three strongest systems in the absorption bands are tabulated, and the results are discussed in relation to previous work.—G. V. R.

***Testing Gun Steel and Other Alloys and Metals for Resistance to Surface Cracking.** Earl Ingerson (*Metals Technol.*, 1947, **14**, (5); *A.I.M.M.E. Tech. Publ. No. 2223*, 13 pp.).—An apparatus is described which enables the surface of a metallic specimen to be submitted to conditions similar to those in a gun as regards temp., pressure developed by explosion gases, and length of time of exposure to the gases. A table is given showing the relative behaviour of various steels, and of nickel, copper, Armeo iron, chromium, molybdenum, tantalum, and of a 50% molybdenum-tungsten alloy. The results for the steels are discussed fully, and some details referring to nickel are also given. In general three types of cracks were developed: (a) Heat-checking cracks which appear first where the hot gases enter the plug; the random nature of these cracks suggests that they are independent of grain boundaries. (b) Coarse cracking which appears readily in brittle materials, and eventually even in materials like gun steel; these cracks may be, but are not always inter-crystalline. (c) Post-fusion cracks which are found where actual melting has occurred. Photomicrographs are reproduced.—W. H.-R.

***Annealing Temperature and Hardness of Tantalum.** J. Neill Greenwood and R. H. Myers (*Nature*, 1947, **160**, (4072), 675).—After cold working at room temp., compacted and sintered tantalum is ductile. After heating at temp. up to 1100° C. in a vacuum (10^{-3} to 10^{-4} mm. mercury), a slight preliminary softening occurs, but after heating at higher temp. the hardness rises steeply to a maximum after heating at 1800° C., and the material is brittle. Hardness falls again at higher temp. The max. value of the hardness depends on the initial amount of cold work, but the temp. at which it occurs does not. Hard tantalum becomes soft again if heated to 2400° C. and quickly cooled, but if slowly cooled (7° C./min.) to 1100° C., it is hard and brittle. Both soft and hard specimens are body-centred cubic, but the latter show diffuse diffraction lines corresponding to a higher value of the lattice spacing. It is suggested that the effects are due to gas absorption during heating even at the low pressures involved, and that the gas is retained at 1800° C. The max. hardness obtained experimentally was 500 D.P.N.—G. V. R.

***Penetration of Magnetic Field Into Supraconductors [Tin, Mercury].** E. Laurmann and D. Schoenberg (*Nature*, 1947, **160**, (4074), 747-748).—Apparatus for examining the variation with temp. of the penetration of a magnetic field into supraconductors is briefly described, and results of measurements on a freshly machined tin cylinder and a slowly frozen mercury cylinder are presented and discussed. $\Delta\lambda$, the variation in depth of penetration, decreases as ΔT , the temp. difference from the transition point, increases. For mercury, different results were obtained with two different specimens, owing to the dependence of depth of penetration on crystallographic orientation.—G. V. R.

***The Kinetics of the Reaction Between Tin and Solutions of Bromine and Iodine in Organic Solvents.** A. F. Trotman-Dickenson and E. J. F. James (*J. Chem. Soc.*, 1947, (Jun.), 736-738).—The rate of loss of weight of a tin cylinder in (a) iodine/carbon tetrachloride and (b) bromine/chloroform solutions showed the reaction to be of the first order with respect to the halogen and the velocity constant to be proportional to the surface area (determined in (b) only). Using bromine/chloroform (b), carbon tetrachloride (c), or ethylene dibromide (d) solutions, the velocity constant was directly proportional to the fluidity of the solvent ($1/\eta$) and to the absolute temp. (determined for (b) only). By rotating the cylinder itself, it was found that the variation of the velocity constant with the rate of stirring was given by $k = Bs + k_0$, where $B = a$ constant, $s =$ revolutions per minute, and $k_0 =$ the velocity constant when there is no stirring.—H. A. H.

***Smears of Titanium Metal.** W. A. Wooster and G. L. Macdonald (*Nature*, 1947, **160**, (4060), 260).—A titanium rod, with an end radius of 1 mm., when drawn over the surface of many substances (including glass) leaves a smear of metal, in spite of the fact that its hardness is less than that of the surface concerned. The smear may be removed with hot conc. hydrochloric acid, and in many cases the surface under the smear is found to have lost its polish. It is suggested that chemical reaction occurs, the titanium probably entering the lattice in the case of silicates. Possible practical applications, such as the formation of high resistances by drawing titanium lines on glass, are briefly discussed.—G. V. R.

***The Electrical Properties and Allotropy of Uranium.** Georg Balz (*Metallforschung*, 1947, **2**, (5), 144–146).—Using uranium of 99.5% purity, resistance measurements show that reversible, allotropic transformations occur at $\sim 670^\circ$ and $\sim 780^\circ$ C. At 20° C. the metal has a specific resistance of 0.372 ohm-mm.²/m. and a temp. coeff. of 1.92×10^{-3} ; tables are given showing the alteration of resistance with temp. up to 1000° C.—E. N.

***Andrade's Creep Law and the Flow of Zinc Crystals.** A. H. Cottrell and V. Aytakin (*Nature*, 1947, **160**, (4062), 328–329).—Single crystals of zinc were extended in creep, using a lever device with an accurately cut profile in order to maintain the resolved shear stress acting on the glide planes in the glide direction constant. Shear strain on the glide planes in the glide direction is plotted against time of loading, and it is shown that the results fit an equation of the form $\gamma = \gamma_0 + \beta t^{\frac{1}{2}} + \kappa t$, where γ is the total shear strain at time t and γ_0 is the instantaneous shear on loading. The constants for this equation in six tests are tabulated, and it is shown that for one case in which $\kappa = 0$, the plot of γ against $t^{\frac{1}{2}}$ is accurately linear, as required by the equation.—G. V. R.

***Calculation of the Tensile Strength of Metals and Its Dependence on the Rate of Loading and Temperature.** Albert Kochendörfer (*Metallforschung*, 1947, **2**, (6), 173–186).—Using as a basis the ideal stress-strain curve data for a single crystal of a face-centred cubic metal, equations are derived which enable the stress-strain relationships and tensile strength of similar polycrystalline metals to be ascertained. Formulæ are also developed which enable the effects of rate of loading and temp. to be ascertained. There is close agreement between the theoretical and experimental results obtained with aluminium and copper, for which adequate single-crystal and polycrystalline data are available. It is shown how, with the exception of metals having a hexagonal crystal structure, the results can be applied to other metals for which no single-crystal data are available.—E. N.

Remarks on Compressive and Tensile Strengths. Stanley Thompson (*J. Appl. Physics*, 1947, **18**, (8), 781–782).—A letter in which the results of Bridgman on the effect of hydrostatic pressure on the fracture of brittle materials (*J. Appl. Physics*, 1947, **18**, (2), 246; *Met. Abs.*, 1947, **14**, 354) are discussed. In connection with the influence of end-effects it is pointed out that, for concrete, the type of failure under one- and two-dimensional loading depends on whether the loading surfaces are lubricated or dry. The relation between compressive and tensile strengths is considered mathematically, assuming the equivalence of breaking stress under one- and two-dimensional loading, as established experimentally for concrete. It is concluded that any departure from the behaviour predicted mathematically is a measure of the experimental departure from idealized end-conditions. Some of the compressive strengths reported by Bridgman may be in error from this cause.

—G. V. R.

Reply to "Remarks on Compressive and Tensile Strengths". P. W. Bridgman (*J. Appl. Physics*, 1947, **18**, (8), 782–783).—Cf. preceding abstract. Bridgman questions the validity of the assumption of the equivalence of

one- and two-dimensional loading in compression, since it depends on results for an untypical material (concrete) at atmospheric pressure, and also suggests that the presence of a superimposed hydrostatic pressure may invalidate T.'s analysis. The effects of end-conditions in B.'s experiments would not be expected to be serious, and experiment suggests that any correction to the strength values obtained would be in the opposite sense to that required by T.'s considerations.—G. V. R.

Mechanical Properties of Metals. N. F. Mott (*Nature*, 1947, **160**, (4073), 696–698).—A summary report of a conference held at the University of Bristol. Among the topics discussed were oxidation hardening, the ordered state in alloys, mechanical properties at low temp., the creep of metals, slip planes in silver halides, crystal boundaries, recovery and recrystallization, diffusion studied by thermo-electric methods, precipitation, elastic after-effects in iron, internal friction, and the properties of sintered compacts. The article stresses the salient points of the contributions, most of which are to be published later.—G. V. R.

Delayed Fracture in Glass. C. Gurney (*Proc. Phys. Soc.*, 1947, **59**, (2), 169–184).—The phenomenon of delayed fracture in glass is fully discussed from the thermodynamical viewpoint, and the paper is of general interest as including extensions to the Griffith crack theory. Various factors which may be responsible for the spreading of cracks are considered, and it is concluded that neither entropy changes due to stress nor evaporation of the reactive material at the base of a crack are likely to be responsible for crack-spreading. Stress causes increased atomic mobility and a faster relaxation towards equilibrium at the base of a crack, while atmospheric attack is also most serious for the highly stressed material in this region. Both these factors contribute towards delayed fracture in glass. A change in the stable phase at room temp. under the action of stress is not likely to be important for glass, but phase changes under stress may have important effects on the behaviour of other materials such as metals.—G. V. R.

An Analysis of the Conditions for Rupture Due to Griffith Cracks. H. A. Elliott (*Proc. Phys. Soc.*, 1947, **59**, (2), 208–223).—Cf. preceding abstract. Theoretical. The Griffith crack theory is extended by means of a more detailed consideration of the inter-atomic forces which resist the spread of a crack. Agreement is found with the experimental results of Griffith.

—G. V. R.

***Upper Yield Point: Occurrence in Bending Tests and Signification.** (Benedicks and Skorski). See p. 334.

The Behaviour of Structures Under Repeated Loads. A. G. Pugsley (*J. Roy. Aeronaut. Soc.*, 1947, **51**, (441), 715–720).—P. points out that while aircraft structural materials have shown a trend towards stronger and stronger materials as measured by static tests, there has been no relative change in fatigue properties. Ability to withstand repeated loadings is important in modern aircraft for the desired effective life. Diagrams illustrating the variation of fatigue range with mean stress for simple specimens and for elementary structures are given and discussed. It is concluded that the more or less continuous vibrations of wings and tail-planes during flight appear likely to have sufficiently serious effects on conventional structures to set a period to the life of an aeroplane that is not remote from the periods contemplated commercially. The wide fluctuations and reversals of tail-plane load that occur in flight may have effects on aeroplane life approaching in severity those of the more or less continuous vibrations. A plea is made for experimental work to establish the resistance of structural units to cycles of fluctuating loading.—H. S.

***Conductivity of Metallic Surfaces at Micro-Wave Frequencies.** E. Maxwell (*J. Appl. Physics*, 1947, **18**, (7), 629–638).—Methods of measuring the effective

conductivities of metals at micro-wave frequencies are described, and details of the techniques discussed. In one method the sample is in the form of a long piece of wave-guide, the attenuation of which is a function of the conductivity, and is experimentally determined. In the second, the sample forms the walls of a resonant cavity, and the conductivity is calculated from the measured characteristics. Results are tabulated for a number of materials, including aluminium, brass, cadmium, chromium, copper, gold, iron, mercury, Monel metal, nickel, silver, solder, and steel, in various surface conditions. In general the high-frequency conductivity is lower than the D.C. value, and the difference is sensitive to surface condition. Drawn surfaces suffer relatively little reduction in conductivity, whereas machined surfaces show a greater effect. The behaviour of plated surfaces varies considerably. The effect is due primarily to surface roughness, and smooth surfaces (e.g. liquid mercury) have conductivities very close to the D.C. values. Abrasion of the surfaces leads to a decrease in the high-frequency conductivity. Thin oxide films are not harmful provided the oxide resistivity is high.—G. V. R.

***On the Chatter of Electrical Contacts.** Wilhem Rump (*Metallforschung*, 1947, 2, (5), 138–144).—A study was made of the chatter of electrical contacts made of pure gold, silver, platinum, tungsten, and nickel, as well as binary alloys of these metals with one another and ternary alloys with copper. Life tests show that there is a gradual change in conductivity leading to increasing resistance and finally to complete non-conductivity. Examination of the surface of the contacts shows that as chatter increases the following processes can be observed as a result of the hammering effect produced by the continual making and breaking of the circuit: (1) the formation of a fine powdery layer on the surface, which adsorbs gases, (2) the deformation of the metal crystal lattice in the vicinity of the position of contact, (3) the transformation of the metal crystals to an amorphous or non-conducting crystalline modification, and (4) the appearance of oxide films due to abrasive action. Pure gold contacts are least subject to chatter, followed by silver, platinum, alloys of gold with 20–40% silver or 5–10% copper, gold–silver–copper alloys, and gold with 5–8% nickel. As little as 0.1% nickel has a deleterious effect on silver. The reasons for the superiority of gold and silver appears to be that with these metals there is a self-healing effect due to the transformation point of the amorphous or non-conducting crystalline form being below room temp., while that of platinum is above room temp.—E. N.

Concerning Estimates of the Minimum Sparking Potential Based Upon the Cathode Work Function. Donald H. Hale and W. S. Huxford (*J. Appl. Physics*, 1947, 18, (6), 586).—With reference to a paper by Jacobs and La Rocque (*J. Appl. Physics*, 1947, 18, (2), 199; *Met. Abs.*, 1947, 14, 354), it is pointed out that the method of determining minimum sparking potentials from work functions for the cathode is unreliable. Several inconsistencies in the implications of the work of J. and LaR. are discussed, and it is concluded that there are many exceptions to their rules. More experimental work is necessary before the situation can be clarified.—G. V. R.

***Concept of the Hydrogen Potential in Steam–Metal Reactions.** Carl A. Zapffe (*Amer. Soc. Metals Preprint No. 15*, 1947, 38 pp.).—Z. reviews the physical chemistry of steam–metal reactions and considers a hypothetical system consisting of a closed chamber divided into two compartments by a diaphragm of the metal being studied. Steam is admitted to one compartment and its partial pressure is maintained const. at 1 atm. The steam reacts with the metal (which is considered to be initially saturated with oxygen) forming metal oxide and atomic hydrogen. Some of the hydrogen dissolves in the metal and eventually diffuses through into the second compartment, where it forms molecular hydrogen; the rest of the hydrogen

remains in the steam compartment, also forming molecular hydrogen. From knowledge of the thermodynamics and equilibrium relations of the reactions occurring, Z. calculates the limiting pressure of molecular hydrogen (equal in the two compartments) which will ultimately exist when equilibrium is reached, and terms this quantity the "hydrogen potential"; the hydrogen potential is a measure of the ability of the metal to absorb hydrogen by the steam reaction. The case of a metal not initially saturated with oxygen is also considered. In this instance an introductory hydrogen potential, fixed by the initial oxygen concentration in the metal, falls to a temporary minimum which occurs when the metal has become saturated with oxygen; at this point oxide begins to form and the reaction proceeds as described above. The theory assumes that oxide formation does not strangle the reaction. Z. applies the theory to a number of problems of interest in connection with ferrous metallurgy, including the reaction with steam of oxygen-saturated liquid iron, the reaction of solid iron in particular at boiler operational temp., the effect of atmospheric moisture on liquid iron, and the effect of various added elements (carbon, silicon, chromium, and aluminium) on the hydrogen potential of liquid iron. Results are presented as graphs showing the variation of hydrogen potential with temp., percentage of added element, &c. Z. concludes that the concept of hydrogen potential explains many phenomena well known in steel-making. Results are also presented for the following elements in the temp. range 1450°–1750° C.: nickel, iron, chromium, manganese, silicon, aluminium, and magnesium. These elements are listed in order of increasing hydrogen potential; the potential for nickel is very small (<0.01 atm.) and explains the fact that this element does not react with steam. The potential of iron is about unity and those of chromium, manganese, and silicon are of the order of 100, 600, and 5000 atm., respectively. The potentials of aluminium and magnesium are far higher, being of the order of 10^6 and 10^8 atm., respectively; these elements have even greater potentials in their melting ranges (that for aluminium at 700° C. being in the region of 10^{14} atm.). The hydrogen-potential concept thus accounts for the extreme readiness with which aluminium and magnesium absorb hydrogen by reaction with steam.—R. W. R.

***Influence of Water on the Lubrication of Metals.** E. D. Tingle (*Nature*, 1947, 160, (4073), 710).—Experiments are described in which the efficiency of lubrication of fatty acids on various metals (including copper, magnesium, and cadmium) is tested under various conditions. Fatty-acid solutions do not provide adequate lubrication in the absence of oxygen, since the chemical reaction responsible for the formation of a metallic soap film takes place via the surface oxide film. The presence of water is also necessary, and the role of this constituent is discussed. It may lead to the formation of a loose hydrated oxide layer of a character suitable for penetration by, and reaction with, the acid, or it may facilitate local ionization of the acid molecules at the seat of reaction.—G. V. R.

Dislocations in a Simple Cubic Lattice. F. R. N. Nabarro (*Proc. Phys. Soc.*, 1947, 59, (2), 256–272).—Theoretical. Using a method of approximation due to Peierls, the properties of dislocations in a simple cubic lattice are calculated. The width of a dislocation is found to be small, and the shear stress required to move a dislocation in an otherwise perfect lattice is about a thousandth of the theoretical shear strength. Further properties, such as the energy of a dislocation, are also considered, and the results discussed in detail, particularly with reference to the relationship between the idealized model and the real crystal.—G. V. R.

Twelfth Report of the Committee on Atomic Weights of the International Union of Chemistry. G. P. Baxter, M. Guichard, O. Hönigschmid, and R. Whytlaw-Gray (*J. Chem Soc.*, 1947, (Jul.), 980–982).—This Report covers

he period 30 September 1940–30 September 1942. No changes have been made in the Table of International Atomic Weights, but it is suggested that the most recent values for samarium (150·38) and ytterbium (173·10) are more reliable than those given in the table, namely 150·43 and 173·04, respectively. In addition, work carried out during this period on the atomic weights of carbon, oxygen, fluorine, zinc, molybdenum, and gadolinium is critically reviewed.—H. A. H.

Thirteenth Report of the Committee on Atomic Weights of the International Union of Chemistry. G. P. Baxter, M. Guichard, and R. Whytlaw-Gray (*J. Chem. Soc.*, 1947, (Jul.), 983–988).—Cf. preceding abstract. In the Table of International Atomic Weights, 1947, included in this Report, the atomic weights of sulphur and copper have been changed from 32·06 and 63·57, respectively, to 32·066 and 63·54. No other changes have been made and values for the new elements 93–96 have not been given. The most recent determinations of the atomic weights of beryllium, carbon, nitrogen, fluorine, calcium, potassium, aluminium, magnesium, sodium, silicon, selenium, ruthenium, silver, bromine, dysprosium, hafnium, lead, and radium are discussed.—H. A. H.

Metallurgy and Atomic Energy.—II, —III. C. Hubert Plant (*Metallurgia*, 1948, 37, (219), 137–140; (220), 178–180).—Cf. *Met. Abs.*, this vol., p. 181. II.—) The structure of the atomic nucleus, transmutation by bombardment with α -particles, the neutron, atomic fission, and chain reactions are explained. III.—) The factors governing the quantity of energy liberated by nuclear fission of a given element are explained.—M. A. V.

II.—PROPERTIES OF ALLOYS

***The Plastic Flow of Aluminium Alloy Sheet Under Combined Loads.**

V. T. Lankford, J. R. Low, and M. Gensamer (*Metals Technol.*, 1947, 14, 5); *A.I.M.M.E. Tech. Publ.* No. 2237, 31 pp.; discussion, No. 2222, pp. 2–33).—The behaviour of the aluminium-clad sheet metals 24S, 75S, and 3301 was studied as regards plastic flow and rupture under a wide variety of combinations of the principal stresses obtained by tests of the following nature: circular hydraulic bulge tests (balanced biaxial tension), elliptical hydraulic bulge tests (unbalanced biaxial tension $\sigma_2/\sigma_1 \cong 0\cdot7$), and simple compression and simple tension using both micro-specimens and standard-size specimens. It was found that specimens $0\cdot04 \times 0\cdot04$ in. could be tested in simple tension and compression with no detectable size effect in the plastic-flow characteristics. The alloys were studied in several conditions of heat-treatment, and the results are dealt with at length.—W. H. R.

***Damping Capacity, Strain-Hardening, and Fatigue [of Aluminium-Magnesium Alloys].** R. F. Hanstock (*Proc. Phys. Soc.*, 1947, 59, (2), 275–287).—

Apparatus for determining the damping capacity of metallic specimens by exciting resonance vibrations electromagnetically is described and illustrated. Results of tests on binary aluminium alloys containing 5 and 11 wt.-% magnesium are presented graphically and in tables, and it is shown that vibrational strains of sufficient magnitude to cause fatigue cracks can be developed. In both alloys, the damping capacity (for a small number of cycles) increases rapidly as the strain is increased above a critical value. Below this value there is a small, practically const. damping capacity, and stress and strain are proportional. Above the critical value, proportionality between stress and strain does not exist, and the mechanism of dissipation of energy is true plastic strain. Consequently changes in properties during vibration result; the specimen strain-hardens and the damping capacity decreases during continued vibration. Experiment suggests that fatigue

failures occur after a certain amount of irreversible strain, or possibly after a certain conversion of energy associated with plastic strain. The endurance is dependent on the amount of irreversible strain per cycle.—G. V. R.

***The New Al-Mg-Zn Alloys with High Mechanical Properties: Zical.** Pierre Vachet (*Rev. Aluminium*, 1947, (134), 189-198; (135), 225-233).—A detailed account of the development by the Compagnie Alais, Froges, et Camargue, and the Compagnie Générale du Duralumin et du Cuivre of the alloy named Zical, and its properties. The work began in 1935, and the French companies early decided to concentrate attention on the alloys containing approx. 8% zinc and 2% magnesium which gave the best promise of high tensile strengths combined with low but still acceptable ductilities. Preliminary work on the effect of chromium and manganese led to the alloy composition zinc 7-8.5, magnesium 2.5, copper 1.5, chromium 0.25%, remainder aluminium, which was finally named Zical. The tendency to intercrystalline corrosion was tested by intermittent immersion in buffered 5% sodium chloride, and early work showed that heat-treatments were dangerous which included a high-temp. quench (e.g. from 460° C.) and reheating for short times at temp. up to 125° C. Anodizing by the sulphuric process conferred complete protection against corrosion. Cladding with aluminium-4% zinc or aluminium-1% zinc alloy sheet was effective against corrosion (by saline mist) for the alloy when quenched and tempered; the cladding was useless for the alloy in the quenched and room-temp.-aged state. The use of super-purity aluminium was not justified, since it did not eliminate intercrystalline cracking. A fairly lengthy discussion of the microstructures is given, and a light-grey chromium-rich phase which may be troublesome in working is touched on. Dilatometric, crystallographic, and radiographic studies were also made; the second showed the presence of $MgZn_2$ and $Al_2Mg_3Zn_3$ phases in the alloy and of a reaction between them at 200° C. Radiography shows that the alloy is prone to inverse segregation of zinc and copper; continuous casting is not possible with the alloy because of the effects of internal stresses which appear when it is so cast. The alloy may be heat-treated to give best results at 465° C., but a bracket of 30° C. is permissible without serious loss of properties; water or oil quenching should be used. The alloy hardens rapidly at room temp., ageing being nearly complete in 2 hr. The recommended reheat is 5 hr. at 135° C.; this ensures immunity from intercrystalline corrosion. Annealing is done at 400° C. for 3 hr. The mechanical properties favour strength rather than ductility (for sheet, elastic limit = 50 kg./mm.²; ultimate tensile stress = 53 kg./mm.², elongation = 14%) and hence it is important to design assemblies to avoid local stress concentrations. Extrusions give the following properties: elastic limit, 60 kg./mm.², ultimate tensile stress, 64 kg./mm.², elongation, 9%; the elastic limit falls 35% as the temp. is raised to 175° C., and hence minor hot working can be done in the temp. range 140°-170° C. The fatigue limit is ± 17 kg./mm.². The hot-working range is 350°-400° C.; the alloy can be riveted but not gas welded; spot welding is possible and gives good results. V. summarizes by the statement of opinion that the real advantages of the alloy counterbalance its difficulties, which can be much reduced by manufacturing care.

—F. A. F.

The Influence of Chemical Composition and Quality of Raw Materials on the Physical Properties of Silumin Gamma.—I. Vlad. Zednik (*Metallurgia*, 1948, 37, (220), 195-200).—After summarizing methods of production and properties of aluminium-silicon alloys, Z. gives an account of experience gained in the war-time mass production of Silumin-Gamma castings at Skoda. Cobalt was added as an iron compensator. Data are given to show the effect of magnesium on the structure and physical properties, and frequency curves of tensile tests of separately cast test bars are presented. When refining with

odium, it was important to prevent excess of sodium in the final product, which would otherwise be porous.—M. A. V.

***Quenching of 75S Aluminium Alloy.** (Fink and Willey). See p. 364.

***On the Warm Ageing of Aluminium-Zinc-Magnesium Forging Alloys.** (Bungardt and Hauk). See p. 365.

Precipitation-Hardening Alloys [Containing Beryllium] and Their Industrial Applications. A. S. Darling (*Mech. World*, 1947, 122, (3176), 549-553).—An elementary account of precipitation-hardening with particular reference to beryllium-copper and other alloys containing beryllium as the hardening addition. The effect of precipitation-hardening on the properties of beryllium-copper is described in fair detail.—R. W. R.

***The Embrittlement of Chromel and Alumel Thermocouple Wires.** (Pumfrey). See p. 360.

***Unsoundness Caused by Gases in Copper-Base Alloys.** L. W. Eastwood and J. G. Kura (*Foundry*, 1947, 75, (5), 80-82, 200, 202, 204, 206, 208).—The first of a series of articles describing the results of a research carried out at the Battelle Memorial Institute. In this first introductory article the problem is defined, and the types of unsoundness (pinhole and microporosity), which may be caused by the presence of gas in copper-base alloys, are considered in a general way. Gas evolution in copper-base alloys is compared with that in light alloys, and it is pointed out that in the former the problem is more complex since two kinds of evolution may occur; these are: (1) precipitation of a dissolved gas (hydrogen, carbon monoxide, carbon dioxide, sulphur oxide, or nitrogen) as in light alloys, and (2) the formation of a gaseous compound by the reaction of oxygen or oxide in the melt with an oxidizable material also dissolved in the melt. The most likely reactions of this type are: $2H + \text{oxide} \rightleftharpoons H_2O$; $S \text{ (or sulphide)} + 2O \text{ (or oxide)} \rightleftharpoons SO_2$; $C \text{ (carburide)} + O \text{ (or oxide)} \rightleftharpoons CO$; $CO + O \text{ (or oxide)} \rightleftharpoons CO_2$. The authors consider briefly the sources of the various gases and gas formers. Some experimental figures are quoted for the quantity of gas (or gas former) required to produce 1% voids at 1066° C. in a solidifying copper-base alloy of density 6 g./c.c. at 1066° C.—R. W. R.

The Theory of Gases in Copper-Base Alloys. L. W. Eastwood and J. G. Kura (*Foundry*, 1947, 75, (6), 82-83, 260-267).—Cf. preceding abstract. A review of published information relating to the absorption of gases by copper-base alloys during melting. The authors first consider the literature relating to the absorption, by pure copper, of the gases hydrogen, oxygen, and sulphur dioxide individually, and then go on to discuss the effect of alloying elements, and hydrogen absorption by the steam reaction. The equilibrium between steam on the one hand and dissolved hydrogen and metal oxide on the other is treated at some length, the effect of dissolved oxygen in limiting the solubility of hydrogen being explained; the effect of additions of reducing alloying elements in modifying the equilibrium relations is described. Mention is also made of the effect of the humidity of the atmosphere. The authors consider the mechanisms of the various reactions occurring and conclude that these cannot yet be fully explained. The phenomena occurring during solidification are discussed, and it is pointed out that enrichment of the residual liquid occurs, which disturbs the gas-metal equilibrium and may cause the evolution of gases, with the consequent production in the casting of porosity, additional to that due to simple rejection of gas from solid solution. The possibility of gas evolution in the solid casting is considered.—R. W. R.

***The Ternary System Gold-Copper-Nickel. II.—Ordering of the Gold-Copper Alloys in the Ternary System Gold-Copper-Nickel.** Ernst Raub and Renemarie Engel (*Metallforschung*, 1947, 2, (5), 147-158).—An X-ray and microscopic study was made of the order-disorder changes in AuCu-Ni and

AuCu₃-Ni alloys containing up to 65 and 72.5 at.-% nickel, respectively. AuCu-Ni alloys were quenched from 970° C. and those of AuCu₃-Ni were quenched from 750° C., and some of the specimens were reduced up to 90% by cold working. The effect of the nickel on the structures at different temp. (300°-400° C.) and times of heating is indicated graphically, and interference diagrams and tables are given which show the alterations in lattice constants, the phases present, and their nickel contents. Unlike silver, which lowers the temp. of ordering, even high concentrations of nickel do not affect the transformations in the gold-copper system. With increasing nickel content, the lattice constants of the superlattice fall steadily at first, and the nickel content of the superlattice rises correspondingly; after the nickel saturation limit of the superlattice (at about 11.5 and 10 at.-% nickel for AuCu-Ni and AuCu₃-Ni, respectively) the lattice constants rise again and a fall in nickel content occurs. Cold working accelerates the transformation considerably, e.g. an unworked AuCu-Ni alloy with 39.2 at.-% nickel when heated for 50 hr. at 360° C. shows only signs of tetragonal superstructure, whereas a worked specimen was completely ordered after 5 hr. at 360° C.; it also has the effect of making the lattice ratio c/a somewhat less than with the unworked specimens, and the effect becomes greater as the nickel content increases. The effect of nickel on the AuCu₃ ordering is less than with the AuCu lattice. The space requirements of the nickel atoms are somewhat less than those of the copper atoms, and it appears probable that in both series of alloys the nickel is statically distributed between the gold and copper atoms.—E. N.

***Ultra-Violet Absorption Band-Systems of PbO, PbS, PbSe, and PbTe.** E. E. Vago and R. F. Barrow (*Proc. Phys. Soc.*, 1947, **59**, (3), 449-457).—*Ch. Met. Abs.*, 1947, **14**, 7, 253. The absorption spectra of PbO, PbS, PbSe, and PbTe were measured in the ultra-violet region ($\lambda > 2050 \text{ \AA}$). Band-head measurements are tabulated, and the vibrational analysis of new band systems of PbS, PbSe, and PbTe is reported. The results are carefully summarized, with data on the appropriate force-constants, but are not discussed in detail.—G. V. R.

The Theory of Limit Design Applied to Magnesium Alloy and Aluminium Alloy Structures. Filadelfo Panlilio (*J. Roy. Aeronaut. Soc.*, 1947, **51**, (438), 534-571).—N. C. Kist of Delft laid down one of the cardinal concepts of "limit design": that in a redundant structure it is not necessary to use the equations of elasticity to determine the redundants, but that it is only necessary to assume values for them, any assumptions at all but preferably the most advantageous ones, provided such assumptions are compatible with the conditions of equilibrium. Van den Broek, in applying the theory to steel structures, emphasized that in all construction the elastic limit has never been a true criterion of strength, but that the true and only criterion has always been deformation. P. deals with the application of "limit design" to light-alloy members of the form of simple beams and redundant beams. The ratio of the load for proportional-limit deflection in the redundant beam to that in the simple beam is about 2 for the light alloys used. Cold-rolled steel gives about the same value, but hot-rolled steel about 1.66. The use of a bending moment observed in the load-deflection list of a simple beam, e.g. that corresponding to the load at which deviation from the straight line is a certain percentage (say 0.2) of the span, is recommended as a basis for design. Other methods are discussed.—H. S.

***The Density of Mg₂Pb, Mg₂Sn, Mg₃Ce(La), and Cerium-Iron Alloys in the Solid and Liquid States.** Franz Sauerwald (*Metallforschung*, 1947, **2**, (6), 188-190).—Tables are given showing the calculated and measured specific vol. and densities of the solid and liquid phases of Mg₂Pb, Mg₂Sn, Mg₃Ce(La), and cerium (97.6%) with 1.9% iron. It is shown that the measured specific

vol. of (a) solid Mg_2Pb is $\sim 3.4\%$ higher than the calculated value, and (b) liquid Mg_2Pb is $\sim 1.6\%$ lower than the calculated value. For Mg_2Sn the corresponding values are $\sim 6.7\%$ and 4.1% , respectively. The $Mg_3Ce(La)$ alloy has measured specific vol. which are lower for the solid and higher for the liquid phases than the calculated values. The results for the cerium-iron alloy are not so well defined. This affords an explanation of the fact that ingots of Mg_2Pb and Mg_2Sn do not show signs of pipes as do ingots of Mg_3Ce . The changes in specific vol. are probably due to differences in the lattice dimensions at high and low temp.—E. N.

***On the Influence of Mercury on the Tensile [and Corrosion] Properties of Magnesium-Manganese Alloys.** Walter Bulian (*Metallforschung*, 1947, 2, 5), 158–160).—A study was made of the microstructure, tensile, and corrosion properties of wires and sheets of magnesium-manganese alloys containing manganese 1.87 and mercury 0–1.8%. The mercury was added in the form of a magnesium-mercury master alloy containing 11% of mercury, and there was no loss of mercury by burning-off or vaporization during the final melting. The microstructure of the alloy containing 0.38% mercury shows the typical segregation of manganese, with mercury in the form of Mg_3Hg as a fine, discontinuous network round the grain boundaries. The mercury additions cause a noticeable decrease in coarse crystal formation on heat-treatment. With 1% mercury the 0.2% proof stress is higher in the case of sheets but lower in the case of wires, than with the straight magnesium-manganese alloy. Mercury below 0.5% has little effect on the tensile properties; the alloy with 1.8% mercury has a 0.2% proof stress of 20.1 kg./mm.² compared with 17.5 kg./mm.² for the magnesium-manganese alloy, although the tensile strengths and elongations are equal. Warm ageing has practically the same effect as with magnesium-manganese alloys. The corrosion properties of the alloys with mercury additions are generally at least as good as, and in sodium chloride solutions somewhat better, than those of the alloy with no mercury. Large cracks appear on welding the ternary alloys due to burning-off of the mercury.—E. N.

***Absorption Bands of Li_2 , Na_2 , K_2 , and NaK .** (Pearse and Sinha). See p. 323.

***Testing Gun Steel and Other Alloys and Metals for Resistance to Surface Cracking.** (Ingerson). See p. 324.

***On the Creep Limit of Zinc Alloys.** O. H. C. Messner (*Thesis: Eidgenöss. Techn. Hochschule, Zürich*, 1947, 54 pp.).—[In German]. Results of an investigation of several commercial zinc alloys containing aluminium and copper, and of rolled and electrolytic zinc samples, are described. Compositions of the materials are tabulated, and comprehensive tables give the essential experimental details (heat-treatment, metallurgical condition, grain-size, and mechanical and physical properties) for the specimens used in the tests. Grain-size and orientation were examined by X-ray methods, and are illustrated by micrographs. The apparatus employed was of conventional design and is described and illustrated. Results are plotted as extension against time for various loads, both directly and logarithmically, and the logarithmic plot of load against creep velocity is also given. In most cases the latter curves show a marked kink, the significance of which is discussed. The effect on the creep of zinc of alloying additions and metallurgical treatment is discussed, and a bibliography of 107 references is appended.—G. V. R.

***Density and Dimensional Changes of Cold-Worked Zinc [–Aluminium–Copper] Alloys.** Karl Löhberg (*Metallforschung*, 1947, 2, (6), 169–172).—The effect of drawing on the density and dimensions of extruded rods of homogeneous zinc-aluminium-copper alloys was determined and, in addition, the simultaneous changes produced in the texture were studied by X-ray methods. The results obtained show the respective parts played by transla-

tion and twinning in the deformation. The alloys studied were (1) zinc with aluminium 1.8, copper 1.2, and magnesium 0.03%, and (2) zinc with aluminium 10, copper 2, and magnesium 0.03%. The reductions were progressively increased from 3 to 85% by small passes. The effects of the reduction can be divided into five stages: (1) 0–10%, a rise in density due to translation, whereby the basal plane of the zinc solid-solution crystals, which is initially parallel to the axis of the rods, changes direction and tends to become transverse to the direction of drawing; (2) 10–25%, a fall in density due to mechanical twinning of the crystals and the consequent formation of small cracks between the crystal boundaries; (3) 25–40%, a rise in density due to further translation; the cracks formed in the preceding process tend to become healed; (4) 40–60%, a fall in density due to the onset of further twinning; and (5) >60%, a rise in density due to further translation, which may be followed by further twinning. Typical density figures for the alloy containing aluminium 2 and copper 1% are: 0% reduction, 6.91; 10%, 6.93; 25%, 6.86; 40%, 6.92; and 60%, 6.87. By removal of the outer skin of the rods, density changes 3–4 times as great are obtained, showing that the changes in the internal structure of the rods are much greater than those which occur on the surface. Concurrent experiments were made to show the effect of ageing the specimens for ~600 hr. at 95°C., and the results show that the changes which occur can be ascribed to recrystallization of the deformed material, which undoubtedly occurs with such extended ageing periods and which increases with increase in deformation.—E. N.

***Evaluation of Aeroplane Metals.** J. A. Van Den Broek (*Eng. J.*, 1945, **28**, (7), 424–439; and *J. Roy. Aeronaut. Soc.*, 1946, **50**, (430), 811–828).—The author discusses the results of observations of the stress-strain characteristics of a number of aircraft light alloys, iron, and stainless steel, and concludes that it seems best to regard cold working as an evil, probably a necessary evil, and not as an advantage unless employed for a definite purpose as, for example, in wires. Tests of columns of equal weight and length in compression showed the superiority of the modern very high-strength wrought aluminium-zinc-magnesium alloys, and that the only competing materials for the award of merit were the magnesium-rich alloys J-1H and O-1HTA, in the long-column range. The author discusses the significance of ductility, and concludes that it is not yet clear how ductility should be determined nor how much is really required.—H. S.

Some Elementary Considerations of the Stress-Strain Curve. R. M. Howarth (*Aircraft Eng.*, 1947, **19**, (226), 372–377).—H. discusses the extent of present knowledge of the stress-strain curve below and above the limit of proportionality. Discussion is mainly a mathematical treatment and deals with Hooke's law, determination of Young's modulus, gauge length, rate of loading, the property e_{\max} , and the determination of proof stresses. Reference is made to the "double modulus"—a peculiarity sometimes exhibited by aluminium alloys in which the test points of the stress-strain curve below the limit of proportionality lie closely on two straight lines instead of one as indicated by Hooke's law. Stress-strain curves are illustrated for D.T.D. 546 (aluminium-clad aluminium alloy sheet) and D.T.D. 364 (extruded aluminium alloy) showing the effect of the "double modulus"; the influence of the "double modulus" on proof stress is also discussed.—W. A. M. P.

***Upper Yield Point: Occurrence in Bending Tests and Signification.** Carl Benedicks and Roman Skorski (*Nature*, 1947, **160**, (4064), 399).—By experiments on soft-iron wire (0.035% carbon) and on carbon-steel wire (1.2% carbon) it is shown that the upper yield point characteristic of tensile tests on these materials also occurs in bending tests. Annealed iron wire shows the effect, but the slightly cold-worked material does not. Heat-treated steel containing grain-boundary cementite exhibits an upper yield

point in bending, but the same steel containing only spheroidized cementite does not. The results are discussed.—G. V. R.

Thermodynamic Relations for Two Phases Containing Two Components in Equilibrium Under Generalized Stress. C. Gurney (*Proc. Phys. Soc.*, 1947, 59, (4), 629–645).—Theoretical. The methods of Gibbs are applied to the thermodynamics of systems under a generalized, as opposed to a hydrostatic, stress. Applications of the formulæ derived are briefly discussed.—G. V. R.

***Some Problems in Unstable Plastic Flow Under Biaxial Tension.** W. T. Lankford and Edward Saibel (*Metals Technol.*, 1947, 14, (5); *A.I.M.M.E. Tech. Publ.* No. 2238, 12 pp.; discussion, No. 2222, pp. 32–33).—The conditions leading to unstable plastic flow have been analysed for (a) direct tensile loads in a plane, (b) combined internal pressure and axial loading of thin-walled tubes, and (c) the hydraulic bulging of a circular diaphragm. The critical rates of strain-hardening at which instability will occur have been derived. The theoretical solutions for uniform strains show excellent agreement with experimentally observed values. The limit of homogeneous deformation does not depend merely upon the state of stress, but is strongly dependent upon the method and geometry of loading. This point is of great importance and must be considered in order to determine what deformation is safe in working processes.—W. H. R.

***A Statistical Theory of Fracture.** J. C. Fisher and J. H. Hollomon (*Metals Technol.*, 1947, 14, (5); *A.I.M.M.E. Tech. Publ.* No. 2218, 16 pp.).—According to Zener and Hollomon (*Trans. Amer. Soc. Metals*, 1944, 33, 163; *Met. Abs.*, 1944, 11, 138) in a two-phase alloy fracture is controlled by defects arising from particles of a second phase or inclusions introduced incidental to the manufacture of the material. This concept alone is not completely satisfactory, and it has been suggested that slip bands behave viscously during deformation and can thus be sources of stress concentration. If in steels the fracture process is determined by carbide particles, other included particles, and slip bands, the numbers concerned are of the order 10^{10} per c.c. The effect of strain, size, and structure must therefore be approached statistically. A statistical analysis is made which is capable of predicting the scatter of fracture-stress measurements for different specimens of a single material. The analysis is based only on the assumption that fracture is caused by randomly oriented defects having the properties of cracks, and that the number of defects of a given size is an exponential function of the size. The theory deals also with the effect of specimen size, and of combined stress and plastic deformation. The agreement with experimental data is discussed.—W. H. R.

***On the Chatter of Electrical Contacts.** (Rump). See p. 327.

The Hole Theory of Diffusion. G. Wyllie (*Proc. Phys. Soc.*, 1947, 59, (4), 694–699).—The movement of solute atoms through a metal lattice, by the mechanism of each solute atom jumping into a neighbouring vacant lattice position, is considered in detail. The activation energy which determines the diffusion is $\epsilon_A + \epsilon_{ABA}$, where the first term is the energy necessary to form a hole next to a dissolved atom, and the second term is the energy of activation for the hole to make one jump round that atom. ($\epsilon_{ABA} - \epsilon_{BB}$), where ϵ_{BB} is the energy of activation for the hole to diffuse away from the dissolved atom, must be considerably greater than kT . The diffusion of a foreign atom in a lattice frequently has a lower activation energy than self-diffusion in the same lattice, and it is shown that this may be due to the relative magnitudes of the separate energy terms involved. The limitations of the model are discussed, particularly with reference to the assumption of next-neighbour interactions.—G. V. R.

III.—STRUCTURE

(Metallography; Macrography; Crystal Structure.)

[For all abstracts on the constitution of alloy systems, including X-ray studies, see II.—Properties of Alloys.]

***Grain Growth in High-Purity Aluminium and in an Aluminium-Magnesium Alloy.** Paul A. Beck, Joseph C. Kremer, L. J. Démer, and M. L. Holzworth (*Metals Technol.*, 1947, **14**, (6); *A.I.M.M.E. Tech. Publ.* No. 2280, 23 pp.).—Isothermal grain growth was studied in rolled strips of high-purity aluminium, and of a high-purity aluminium-magnesium alloy containing 2.1% magnesium. The temp. used were between 350° and 650° C. In both alloy and pure metal, regardless of temp. and amount of prior deformation, the average grain-size ceases to increase after reaching a value approx. equal to the strip thickness. When, however, grain growth is not limited by strip thickness, the grain-size continues to increase for periods as long as 11 days, and the experimental results do not confirm the view that a finite "ultimate grain-size" is approached. The average grain diameter increases approx. proportionally to a fractional power of the annealing time. The fractional exponent increases with temp. up to a value of approx. 0.45. The effect of 2.1% magnesium in solid solution is to decrease the grain-size after recrystallization at a given temp., and to increase the fractional exponent which determines the rate of grain growth and its decay.—W. H.-R.

***Growth of Stimulated Crystals and Rate of Nucleation During Recrystallization of Aluminium.** W. G. Burgers (*Nature*, 1947, **160**, (4064), 398–399).—B. refers to the fact that while the rate of crystal growth during recrystallization of aluminium is independent of time, the rate of nucleation increases with time (Anderson and Mehl, *Trans. Amer. Inst. Min. Met. Eng.*, 1945, **161**, 140; *Met. Abs.*, 1945, **12**, 213). This implies that some sort of nucleation stimulus occurs, probably in the nature of a deformation. The actual occurrence of such stimulation follows from examination of recrystallized aluminium sheets, which show many crystals as pointed inclusions at the edges of larger crystals. The growth of such larger crystals does not begin until another crystal has grown into contact with the nucleus. Nuclear spots, which by themselves cannot grow, are made to grow by contact with another crystal which is already growing. A theory of the physical mechanism of the stimulation is suggested, based on the fact that the stimulating and stimulated crystals have a (111) glide plane and a [110] glide direction in common. It is suggested that, on contact, a "discharge" of the dislocations held up in the nuclear spot might be brought about along the common glide plane and direction, which might give the nucleus the faculty to grow. The process is discussed.—G. V. R.

***The Influence of a Thermal Pre-Treatment on the Crystal Size of Age-Hardened Sheets of a Duralumin-Type Alloy After Critical Deformation.** Guido Bassi (*Metallforschung*, 1947, **2**, (6), 191–192).—Sheets of an aluminium alloy containing copper 4.22, magnesium 0.77, manganese 0.68, silicon 0.45, and iron 0.35% were given a 50% reduction, solution-treated in a salt bath for 2 hr. at 510° C., quenched and heated at temp. between 50° and 300° C. for 24–72 hr., then given a further 10% extension, solution-treated again for 30 min. at 510° C., quenched, and the microstructure examined with reference to coarse crystal formation. It is shown that by intermediate ageing for 72 hr. at 150° C., or 24 hr. at 250° C., the final product has a grain-size equal to that of the original material, with no tendency to coarse crystal formation. Such intermediate ageing causes CuAl_2 to be precipitated as fine grains round the crystal boundaries, which hinders crystal growth on subsequent solution

treatment, even though the CuAl_2 does finally again go into solution. Ageing at higher temp. causes the CuAl_2 to coagulate.—E. N.

***Activation of Copper by Oxidation and Reduction.** (Aldred and Happey). See p. 322.

***Determination of the Crystal Structure of Gold Leaf by Electron Diffraction.** F. B. Rymmer and C. C. Butler (*Proc. Phys. Soc.*, 1947, **59**, (4), 541–554).—The accuracy obtainable using the authors' technique of electron diffraction is discussed in detail. The standard deviation in the measurement of the radii of diffraction rings is established by four independent methods, the results of which agree well to give a value of the order of $3\ \mu$. The technique is applied to the study of gold leaf, and it is shown that the diffraction-ring radii are not in exact agreement with theory. The effect is such that the wave-length λ calculated from the (200) ring is higher than would be expected from the results for the (311), (220), and (111) rings, and the anomaly varies proportionally to λ . The addition of impurity tends to reduce the anomaly, which is not due to strain of the type removable by annealing. Several possible causes of the anomaly are considered, and it is concluded that the most probable explanation lies in the existence of a surface tension in laminae not normal to the beam. The fact that no marked ellipticity develops when the laminae are not normal to the beam suggests that the specimen actually consists of a number of laminae of random orientation having a thickness of the order of 4×10^{-7} cm., assuming a surface tension of 500 dynes/cm. The effects of a stress system due to surface-tension forces are discussed in detail, with special reference to the diffraction phenomena.—G. V. R.

***Diffraction of X-Rays by the Alloy AuCu_3 .** I. G. Edmunds, R. M. Hinde, and H. Lipson. A. J. C. Wilson (*Nature*, 1947, **160**, (4061), 304–305).—Experimental work on a single crystal of AuCu_3 , carried out by X-ray oscillation photograph methods, is described. The work was undertaken in order to test Wilson's theory of the diffraction effects (*Proc. Roy. Soc.*, 1943, [A], **81**, 360; *Met. Abs.*, 1944, **11**, 14), and to examine the theory put forward by Strijik and MacGillavray (*Physica*, 1946, **11**, 369; **12**, 129). It is shown that the experiments of S. and MacG. do not give a critical test of their theory owing to the orientation of the crystal used. The shapes of the superlattice spots observed in the work of E., H., and L. are in better agreement with V.'s work. W. points out that it is possible to construct several models for the state of the ordered alloy, one of which will account qualitatively for the results of S. and MacG. and of E., H., and L. Comparison between theory and experiment is worked out semi-quantitatively, and the need for further work is stressed.—G. V. R.

***Metallography of Hot-Dipped Galvanized Coatings.** D. H. Rowland (*Amer. Soc. Metals Preprint No. 18*, 1947, 24 pp.).—R. commences with a general discussion of hot dipping and points out that coatings produced by this process are essentially duplex in nature, consisting of a layer of the pure coating metal (or a solid solution) on top of an interfacial alloy which may itself be complex, being made up of layers of a number of different phases. In binary systems all the solid phases which appear in the constitutional diagram at the dipping temp. should be present in the coating in the order of their occurrence in the diagram. It has previously been difficult experimentally to demonstrate this owing to lack of a suitable etching reagent. The part played by diffusion in the growth of coatings is discussed. The Phase Rule shows that only single-phase diffusion layers can exist in binary systems; hence two-phase regions can only occur as interfaces between two single-phase layers. The results of the more reliable investigations of the iron-zinc diagram are summarized. Some experimental coatings were prepared by the immersion of 0.08%-carbon steel in a bath of Prime Western spelter at 450°C . for up to 2 hr. According to the iron-zinc diagram,

these coatings should contain the following phases: α , Γ , δ_1 , ζ , $\zeta + \eta$, and η . The existence of all these phases was confirmed metallographically with the aid of a new etchant containing 0.3 g. picric acid, 10 ml. ethyl alcohol, and 50 ml. water (the relative proportions of the three constituents are varied to suit different types of coating). Numerous photomicrographs from these specimens are reproduced. Curves are presented which show the rates of growth of the different phases. The different phases do not maintain their relative widths during growth; the Γ phase reaches max. thickness in 1 min.; the ζ phase grows rapidly at first but its rate of growth falls off, so that after 100 min. it is less than that of the δ_1 phase. The results of Knoop hardness tests on the various phases are given. Some commercial coats were also examined. All the phases shown by the constitutional diagram were again shown to occur; the alloy layer consisted largely of ζ , except in the case of aluminium-bearing coats, when the predominant phase was $\zeta + \eta$. In galvannealed coats, η was nearly absent, being replaced by $\zeta + \text{ZnO}$. The presence of tin up to 1.0% does not affect the metallography. R. discusses the superior adherence of coatings on silicon-killed steel and suggests that this may be due to the thinness of the Γ layer in such coatings, and not to a mechanical locking effect as frequently supposed. The effect of aluminium in modifying the thickness of the coating is discussed, and an explanation is offered for the local flaking encountered with aluminium-bearing coats. The total thickness of aluminium-bearing coats may be revealed by etching first in dil. nitric acid (5 drops HNO_3 /50 ml. water), drying, re-etching in ferricyanide reagent (0.5 g. $\text{K}_3\text{Fe}(\text{CN})_6$, 50 ml. water, 50 ml. alcohol, 2 ml. NH_4OH), and finally brushing with amyl alcohol.—R. W. R.

***Quantitative Metallography by Point Counting and Lineal Analysis.** Robert T. Howard and Morris Cohen (*Metals Technol.*, 1947, **14**, (5); *A.I.M.M.E. Tech. Publ. No. 2215*, 14 pp.).—Previous work on methods for determining the relative percentages of phases in a specimen from observations on the microstructures of plane sections is reviewed. Much work of this kind was done in the development of geology and mineralogy, and has not been recognized by metallurgists. The lineal method is preferred, and the electric semi-automatic counter of Hurlbut (*Amer. J. Sci.*, 1939, **237**, 253) is described. Standard steel specimens with const. but different proportions of martensite and austenite were etched so as to show the two constituents in strong black and white contrast. The relative proportions were estimated visually by independent observers and then examined by different counting methods, and the results are discussed. Visual observation may be inaccurate even though different observers agree. Counting methods can give an accuracy of \pm a few per cent., and the technique could be used in many metallographic problems.—W. H.-R.

Metallography for the Electroplater [—II]. (Blazy and Mohler). See p. 351.

Progress in Electron Microscopy. P. Reed (*Nature*, 1947, **160**, (4074), 762–763).—A summary report of a conference of the Electron Microscopy Group of the Institute of Physics, held at the University of Leeds. Much of the subject matter of the conference was biological in nature, but the résumé of the contributions to problems of technique and photography is of interest to metallurgists.—G. V. R.

Electron-Beam Deflection. I.—Small-Angle Deflection Theory. R. G. El Hutter (*J. Appl. Physics*, 1947, **18**, (8), 740–758).—A mathematical analysis of the effects of electric and magnetic deflection fields on electron beams.

—G. V. R.

***Electron Optics and Space Charge in Strip-Cathode Emission Systems.** O. Klemperer (*Proc. Phys. Soc.*, 1947, **59**, (2), 287–302).—Experiments set up to examine the spreading of electron beams due to the influences of space-charge effects are described and theoretically discussed.—G. V. R.

***Refraction Effects in Electron Diffraction.** J. M. Cowley and A. L. G. Rees (*Proc. Phys. Soc.*, 1947, 59, (2), 287–302).—Electron-diffraction rings of certain materials (inorganic oxide smokes) show a fine structure under high resolution. The characteristics of the fine structure observed on tilting oriented specimens are described and discussed, and examined from the point of view of refraction at the faces of the regularly shaped particles. The refraction theory is developed, and general expressions are derived for the deviation of the diffracted beam owing to refraction at the faces of cubes. The expressions are applied to particular cases, and complete agreement with experiment is found. Refraction, even for particles of irregular shape, broadens diffraction rings, and gives rise to line-breadth and intensity anomalies in diffraction patterns from specimens of regular crystal habit.—G. V. R.

***Single-Crystal Electron Diffraction by Micro-Crystalline Materials.** Norman Davidson and James Hillier (*J. Appl. Physics*, 1947, 18, (6), 499–511).—A two-lens electron-diffraction camera in which the electron beam forms a probe of very small dimensions is described. The beam is focused to a point either coinciding with or slightly displaced from the specimen plane. Under these conditions, electron-diffraction patterns of single microscopic crystals (200–2000 Å) may be obtained. When the beam is focused on the specimen, Kikuchi-line patterns are observed. When it is focused between the specimen and the recording film, a two-dimensional grating pattern results, in which each spot is, in general, a dark-field shadow image of the diffracting crystal. Examples of patterns obtained are reproduced. The results are considered in terms of the dynamical theory of electron diffraction. It is shown that the two-dimensional grating pattern results from a crystal oriented with an important lattice vector approx. parallel to the electron beam, independent of slight disorders or warping of the crystal, provided the crystals are not too thick. Kikuchi-line patterns are to be expected for most other crystals which are not excessively thick or disordered. Both types of pattern may be obtained simultaneously. Accurate values for some lattice spacings may be obtained from either type, while from the Kikuchi-line patterns the orientation of the crystal relative to the beam may be accurately determined.—G. V. R.

X-Ray Analysis in Steel Industry. — (*J. Sci. Instruments*, 1947, 24, (10), 266–273).—A summary of papers presented at the X-Ray Analysis Group's Autumn 1946 Meeting. The following items are of general metallurgical interest: "Intensity Relations of Debye-Scherrer Powder Diffraction Lines", by A. J. Bradley. The sources of line broadening and displacement can be divided into three groups: (1) geometry of the camera, specimen, and source of X-rays, (2) photographic difficulties, (3) the natural inhomogeneity of X-rays. Previous work is summarized, and new experiments with copper and platinum wires are described. In the discussion, G. W. Brindley emphasized that where there was marked absorption contrast between the components of an alloy, differential absorption effects occurred which made it impossible to judge the relative proportions of different phases from the relative intensities of diffraction lines. D. L. Lipson remarked on the wave-length spread exhibited by all characteristic radiations. "Application of X-Rays to the Study of Internal Stresses and Deformation in Metals", by W. A. Wood. W.'s work on internal stresses in metals and on the breaking up of metals into crystallites during deformation is summarized. In the discussion, D. L. Lipson disagreed with W.'s interpretation of line broadening, and regarded it as due mainly to internal stresses. T. Ll. Richards considered it was now established that internal stress was the main factor in line broadening. This does not mean that crystallite formation is absent, but that the estimates of particle size given by Wood are wrong. G. W. Brindley stated that measurements on filings of copper, nickel, and rhodium

indicated that internal stress was the main cause of line broadening. G. B. Greenough discussed the difficulties arising from the elastic and plastic anisotropy of crystals. "An X-Ray Diffraction Investigation of Electrodeposited Chromium", by H. J. Goldschmidt. Previous work on electrodeposited chromium is reviewed, and new work is described which indicates that the base metal may play an important part in determining the structure of the deposit. Back reflection X-ray diffraction photographs of rather soft chromium plated steel showed in general two rings corresponding to the (211) reflections from the chromium and from the underlying iron. Good hard chromium plating, on the other hand, showed one broad diffuse ring with its max. intensity in the region between the positions where the separate rings would be. This indicates bonding between the iron and the chromium. Experiments on the liberation of hydrogen are described. In the discussion G. W. Betteridge described experiments on thick layers of electrodeposited chromium, and emphasized that the existence of preferred orientation in chromium deposited on metal with randomly oriented crystals was difficult to reconcile with the idea that the basis metal played an important part. "Some Successes and Failures in the Application of X-Rays to Industrial Problems", by A. H. Jay. Attempts to determine the nature of graphite flakes in cast iron by X-ray methods were unsuccessful owing to faulty technique in preparation which resulted in the soft graphite being worn down below the surface of the iron so that the X-rays did not reach them. Internal stresses in heat-treated low-alloy constructional steels could not be determined because the high-angle X-ray reflections were blurred into the background and lattice spacings could not be measured accurately. Successful solutions of problems on refractories are described. "The Surface Structure of Metals", by G. I. Finch. Electron-diffraction methods have confirmed the existence of the so-called Beilby layer on polished metals. Electron-diffraction methods have also shown that the reason why aluminium alloy pistons last longer if they contain magnesium is the formation of a surface layer of amorphous spinel. Interesting results for the structure of surface films of one metal deposited on another were obtained and are described.

—W. H.-R.

*An Electronic Computer for X-Ray Crystal-Structure Analyses. (Pepinsky). See p. 358.

*Two Calculating Machines for X-Ray Crystal-Structure Analysis. (Booth). See p. 358.

Micro-Radiography. F. W. Von Batchelder and J. H. Schaum (*Iron Age*, 1947, 160, (24), 94-97).—Micro-radiography is the technique by which radiographs of structures of materials are examined under magnification. B. and S. briefly describe the method of producing micro-radiographs, and, by comparing these and photomicrographs of identical structures of cast iron, bronze, and an aluminium alloy, illustrate the basic differences in results observed by the two procedures. They emphasize that micro-radiography is accessory to and not a substitute for photomicrography.—J. H. W.

*Residual Lattice Strains in Plastically Deformed Metals. G. B. Greenough (*Nature*, 1947, 160, (4060), 258).—Annealed metal wires (iron and magnesium) of 0.5-mm. dia. were extended plastically to breaking point and exposed to X-rays in a 19-cm. Bradley-Jay powder camera. The residual strains for each reflecting plane were obtained by comparing the lattice spacings of the deformed metal with those deduced from powder photographs of the same specimens after re-annealing. The strains were measured in a direction normal to that of the applied stress. Results are tabulated and show that the residual stresses for different planes exhibit differences in sign. Similar results were obtained for copper and aluminium. The results are discussed, and confirm that the X-ray technique picks out grains of certain

orientations only. The strain in these grains is not the average of the strains in all grains, but is a mean of the strains in grains with particular orientations. Thus positive and negative values for the strain may be found according to the plane studied.—G. V. R.

†**Relation of Machinability to Structure: Non-Ferrous Metallurgy.** (Murphy); see p. 366.

V.—POWDER METALLURGY

Powder Metallurgy in Great Britain. W. D. Jones (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 1–2*).—A brief historical note on the development of powder-metallurgy techniques in Britain, starting from the industrial use of powders developed by Bessemer and by Vollaaton.—G. V. R.

Production of Ferrous and Non-Ferrous Metal Powders. G. L. Miller (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 3–14*).—The following processes for the production of metal powders are reviewed: milling, machining, atomization, granulation, graining, reduction of metallic oxides, reduction of metallic salts, electrolysis, decomposition of carbonyls, and the decomposition of hydrides. Specific applications of each process and the characteristics of the powders produced by these methods are discussed, and certain other processes referred to. A comprehensive table summarizes the normal methods of preparation and the properties of the commoner industrial metal powders.—G. V. R.

Flake Metal [Aluminium, Copper, and Bronze] Powders—Their Application, Manufacture, and Testing Methods. H. Meyersberg (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 37–46*).—The physical properties of flake and granular aluminium, copper, and bronze powders are compared, and the importance of the flake powders in industry for special applications is stressed. The material finds applications in the paint industry because of its superior covering power and lustre, and in making light-weight concrete and pyrotechnic materials. The usual methods of manufacture are the stamp mill, in which there is risk of explosion, and the modified ball mill, which can be used without risk by the provision of an inert atmosphere. The modification introduced into the ball mill consists of a baffle arrangement which lifts the balls to near the top of the drum, from which they drop to give a hammer action on the particles. The processes are described in detail and the equipment illustrated. The testing of the flake product is described. Covering power is measured by sprinkling the powder on to a water surface, which is decreased by a movable flame until the surface is completely covered and wrinkles appear. The capacity for forming mirror-like paint films is best assessed visually. Fatty-acid contents are determined by soxhlet extraction, and particle size distribution by wet or dry lifting. Combustion properties of aluminium flake, and the emissivity of metal-painted surfaces are referred to, and the recent use of flake aluminium as a lubricant at the walls of dies used for making granular aluminium compacts is described.

—G. V. R.

Comparison of Magnetic Powder [Nickel-Iron and Iron] Cores for High and Low Frequencies. G. R. Polgreen (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 52–58*).—The properties of magnetic cores made from metal powders (chiefly nickel-iron alloys and carbonyl iron powders) are summarized. The cores consist of fine high-density powder, each particle of which is coated with an insulator, and the whole is mixed with a binding or filling agent to give any desired permeability in the range 6–120. Eddy-current losses are minimized by using fine powders of high electrical resistivity. Particle sizes of 40–200 μ are suitable for low-

frequency use, but sizes down to 2-5 μ are necessary for radio-frequencies. Hysteresis and residual losses are dependent on the material and its metallurgical history. In order to make the annealing of cores possible for the relief of strains after compacting, the insulating and binding material should be ceramic in nature. The required properties of cores for different frequencies are tabulated, together with the actual properties of the magnetic materials now available. Non-powder cores and nickel-iron powder cores are critically compared, and experimental means of assessing the quality of the compacts are discussed. At low frequencies, high-nickel nickel-iron powders give the best high-permeability and low-loss material. For medium frequencies, though iron gives comparable permeability figures, nickel-iron alloys give lower losses. At high frequencies carbonyl iron is at present preferable owing to better physical properties, but full development of the possibilities of iron-nickel alloys has not been obtained.—G. V. R.

Nickel-Iron Alloy Dust Cores. S. E. Buckley (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 59-63*).—The general requirements for magnetic powder cores are discussed with special reference to telecommunications equipment. For a high and const. permeability with low loss, the most useful materials are electrolytic iron, Permalloy, and molybdenum-Permalloy. The development of powder-core technique is given and illustrated with reference to these materials, and the present methods, using ceramic insulation of particles and pressure forming of the core, are discussed. The changes of permeability with applied magnetizing force and with frequency in sheet or strip materials and in the corresponding dust cores are graphically compared, and reference is made to the calculation of the core permeability from the intrinsic properties of the bulk material. The resistance characteristics of dust-cored coils are considered, and the account stresses the importance of high-permeability-low-loss cores for producing low-resistance coils of small size for audio-frequency use. The optimum permeability depends on the frequency, and this should be taken into account in design.—G. V. R.

The Production of Sintered Permanent Magnets. S. J. Garvin (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 67-72*).—Modern permanent-magnet materials are hard, brittle, and resistant to machining, but complex forms may readily be made by powder methods. The industrial production of sintered permanent magnets of iron-nickel-aluminium alloys is described stage by stage. The presence of oxide films on the surface of aluminium particles interferes with the bonding of the complex and precludes the use of the material. Good results are obtained by using binary alloys of aluminium with iron or cobalt, together with annealed electrolytic iron and copper powders and carbonyl nickel, in making the initial mixtures. Particle sizes should be non-uniform for securing good "green" compacts, and the powders should be soft, malleable, and of high bulk density. Die design is discussed, and guiding principles are given for a recommended pressure of 25-40 tons/in.² When sintering (2 hr. at 1300° C.) stringent precautions against oxidation are necessary; these take the form of preferential oxidation of a relatively reactive packing material during heating in commercially-pure dry hydrogen. The linear shrinkage on sintering is 5-7%, and densities of 96% of that of the solid alloy are obtained. The magnetic properties of the material are tabulated, and process control and dimensional tolerances are discussed.—G. V. R.

The Preparation of Carbides. L. D. Brownlee, G. A. Geach, and T. Rainey (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 73-78*).—Methods and apparatus available for the preparation of carbides and double carbides of tungsten, titanium, and tantalum are given. Tungsten carbide is obtained by mixing tungsten powder (impurities not >0.2%) with

slight excess of lampblack in a ball mill, and heating by induction in a non-oxidizing atmosphere after light pressing into porous compacts. Carburization of powder of grain-size $2-3\ \mu$, heated for 2 hr. in hydrogen is complete at 1440° – 1410° C., but higher temp. (up to 1500° C.) may be required industrially. The carbide is broken up and milled to a powder passing a 200-mesh sieve. In the case of titanium carbide, titanium powder is reactive and difficult to produce; thus commercially pure oxide is reduced with a slight excess of carbon, in a vacuum to prevent accumulation of carbon monoxide. Mixing is done wet, and the mixture subsequently dried and pressed. The pressing is heated *in vacuo* at 1900° – 1950° C. for 30 min. If hydrogen is used, the carbon content is low and a temp. of 2100° – 2200° C. is necessary. A similar process is used for making tantalum carbide, heating being carried out for 2 hr. at 1600° C.; the metal may be carburized in hydrogen at 1600° C. Tungsten–titanium carbide is made as an equimolecular solution of the binary carbides by heating the mixed powder *in vacuo* at 1800° C. for 2 hr. The characteristics of double carbides containing tantalum carbide are considered, and the preparation of cemented carbides from the powders and cobalt is briefly discussed.—G. V. R.

The Manipulation and Sintering of Hard-Metals. H. Burden (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 78–83*).—The stages in the production of tungsten carbide–cobalt and titanium carbide–tungsten carbide–cobalt alloys, starting from prepared powders, are discussed in detail. Satisfactory finished products may be obtained after pressing within a wide range of pressures (0.25 – 40 tons/in.²). Pressings may be made in the form of rectangular blocks which are subsequently cut to shape, or pieces may be pressed to the finished shape. Control of dimensions is governed by the pressing process, either by using a const. pressure, or by pressing to a given density. Pressures and die design depend on powder size, and typical faults, and the choice of lubricants, are discussed. The compact is pre-sintered in hydrogen or in a vacuum with slow heating, to give strength for forming and to expel lubricants, and necessary precautions are stressed. Shaping operations may be done by diamond tools or by grinding. The sintering process and the necessary equipment are considered in detail, liquid cobalt being involved at 1350° – 1550° C. Details differ for different grades of material, and the control of the carbon content is important. Factors affecting the carbon content at various stages in the process are considered, together with the effect of composition changes in general. It is pointed out that care in design and control of equipment is as important as composition control.—G. V. R.

***The Physical Metallurgy of Sintered Carbides [Tungsten–Carbon–Cobalt Phase Diagram].** E. J. Sandford and E. M. Trent (*Iron Steel Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 84–91*).—The theory of the sintering process, with special reference to tungsten carbide–cobalt alloys, is considered in detail, on the basis of experiments on the contraction of specimens during sintering. Contraction begins at approx. 1150° C., before any liquid phase is present, and is not complete until some time after the appearance of liquid. An approx. pseudo-binary tungsten carbide–cobalt phase diagram is presented, and used for describing the sintering process. The first stage involves recrystallization of the cobalt grains, which weld together. Above 1200° C., tungsten carbide dissolves to some extent and contraction occurs owing to the grain growth of cobalt. At 1320° C. a eutectic liquid forms and wets the carbide grains; surface-tension effects aid further contraction. In the final stages, homogeneity and freedom from porosity are obtained. During sintering, tungsten carbide tends to recrystallize to a regular crystalline form, and fairly strong grain boundaries may be formed between carbide particles. The nature of the cobalt-rich phase is

discussed, and it is shown to be larger-grained and cubic in structure. Owing to variations in carbon content, additional phases may occur. Graphite appears if the carbon content is high. If the carbon content is low, an η phase occurs, which is a double carbide of tungsten and cobalt, is probably stable, and leads to mechanical weakness. Certain aspects of the tungsten-carbon-cobalt phase diagram are discussed, and the physical properties of sintered carbides are reviewed.—G. V. R.

The German Hard-Metal Industry. G. J. Trapp, B. E. Berry, H. Burden, A. E. Oliver, and T. Raine (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 92-98*).—A general account of the techniques of preparing and processing materials for hard-metal manufacture in Germany. Reduction of tungstic acid and ammonium para-tungstate in small rotary kilns using a hydrogen atmosphere is described, and improvements in ball-mill technique reported. Apparatus for pressing tool tips to the finished form is illustrated, and die design for special purposes is discussed. The partially successful substitution of molybdenum carbide for tungsten carbide is referred to, and other attempts to find satisfactory substitutes are dealt with. Tools made by hot-pressing mixtures of cemented tungsten carbide and diamond are discussed, and a summary of general research carried out on hard metals in Germany is given.—G. V. R.

***The Structure of Porous Bronze Bearings.** A. Carter and A. G. Metcalfe (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 99-105*).—Samples of porous bronze bearings from three manufacturers were examined by chemical, physical, mechanical, metallographic, and X-ray methods. Composition, density, hardness, and graphite grain-size are tabulated, and the porosity is illustrated by photomicrographs. X-ray examination showed results that were more representative than those of metallographic examination, and spacing measurements of the α -solid-solution matrix are reported. Experiments on the production of porous bronze bearings showed that the variation of the tin content in the matrix, and the general structure, depended on sintering temp. If this was greater than 798° C., the temp. of the peritectic reaction, the bearing was more compact, with isolated and not connected voids, and inferior in performance. The composition of the matrix was uniform and led to sharp X-ray reflections. Below 798° C., a homogeneous solid solution cannot be obtained in the usual times of sintering, and other phases are present in addition to the matrix of variable composition. The effect of other factors, such as time of sintering, grain-sizes of powders, and compacting pressure, are also discussed.

—G. V. R.

Highly Porous Metal Compacts, with Special Reference to Filters. C. E. Sinclair (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 105-109*).—Powders for the production of highly porous compacts for filters must be of uniform size and of spherical particle shape. Close-packing is approx. obtained, and porosities of 37% are usual. The porosity does not depend on powder size, which, however, determines the filtering characteristics. Photomicrographs of typical filter materials are given. Atomized bronze powder is used, after screening, for production purposes. The mechanical properties after sintering are low compared with normal sintered products, but the compacts are ductile and more resistant to shock than ceramic filters. Flow and pressure drop characteristics are discussed and illustrated graphically, and typical applications are quoted.

—G. V. R.

Aircraft Liquid De-Icing Equipment. — (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 110-112*).—A short report of the development, design, manufacture, assembly, and performance of porous metal distributors for de-icing fluid on the leading edges of aircraft.

wings. The essential feature is a porous copper-nickel-tin wall through which adjusted quantities of fluid can exude from a reservoir on to the wing surface.—G. V. R.

Powder-Metallurgy Bearing Materials—A Note on Powder-Metallurgy Methods Used in Great Britain for the Manufacture of [Copper-Lead] Plain Bearings and Thrust Washers. W. H. Tait (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 151–161*).—Powder metallurgy may be used for producing structures which are difficult to make by other methods. The porous “self-lubricating” bearing is described, and the use of powder metallurgy to produce desirable copper-lead bearings of controlled grain-size in which both phases are continuous, rather than one continuous and the other discontinuous as in cast alloys, is discussed. Details of the production processes for both porous and non-porous components are given, and possible future developments are considered. The influences of structure on the behaviour of copper-lead bearings, and of elastic modulus on bearing behaviour, are discussed in two Appendices.—G. V. R.

***The Pressing and Sintering of Copper Powders.** Maurice Cook and S. F. Pugh (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 162–173*).—The results of an examination of the physical properties and behaviour of copper powders in pressing and sintering are described. Powders were of electrolytic origin (dendritic), as prepared by hydrogen reduction (angular), and as made by chemical precipitation (dendritic). Powders of various sizes were used and the screen analysis is given, together with the flow properties, apparent density, and max. density. Test rings of rectangular cross-section were pressed and sintered in a hydrogen atmosphere. Dimensional changes on sintering were greater in the direction of pressing than at right angles. The rings were tested by stretching them on semi-cylindrical formers, and the test was calibrated with similar rings of massive copper of known physical properties. Micrographs of the three powders at various stages of compacting and sintering are given, and the results discussed. The use of zinc stearate as a lubricant was investigated; though the friction decreases with increasing stearate, the steepest fall occurs with the first addition. Dimensional changes on sintering are considered in detail. It is concluded that in general the tensile strength of the finished article increases progressively with an increase in the compacting pressure, sintering temp., and fineness of powder.—G. V. R.

***The Production of Some Non-Ferrous Engineering Components by Powder Metallurgy.** J. W. Lennox (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 174–184*).—A report of an investigation to ascertain the optimum techniques for the commercial manufacture of high-density non-ferrous components by powder methods. It is recommended that 70 : 30 brass be made by cold pressing the fully alloyed powder at 30–35 tons/in.², sintering at 900° C., and re-pressing at 30–35 tons/in.². The resulting compact has a tensile strength of 15 tons/in.², an elongation of 14%, and a density of 7.69 g./c.c. For a 90 : 10 bronze, extra-fine powders are pressed at 30 tons/in.², sintered at 800° C., re-pressed at 30 tons/in.², and re-sintered at 800° C. The tensile strength is 12 tons/in.², with an elongation of 10%, while the density is 7.9 g./c.c. Practical considerations of die design for different shapes and thicknesses are discussed, and some components successfully made are described and illustrated.—G. V. R.

***Aluminium-[Copper] Components [by Powder Metallurgy].** R. L. Bickerdike (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 185–191*).—Experiments on the sintering of aluminium powder, made by atomization, with 6% copper powder are described. Pressing was carried out with colloidal-graphite lubrication, and sintering was done in pure hydrogen or in a vacuum. Compacts were quenched from 500° C. and aged at

room temp. Microscopic examinations, and density, hardness, and tensile tests were carried out on the compacts and the specimens were analysed. Results are discussed, and it is shown that the cold pressure and the sintering temp. have a critical effect on the properties of the sintered material. High pressures are not necessary, and a tensile strength of 21.3 tons/in.², with an elongation of 4.5%, is obtained with a cold pressure of 20 tons/in.² and a sintering temp. of 575° C.—G. V. R.

Notes on German Developments in Non-Carbide Powder Metallurgy (1939–1945). C. J. Leadbeater (*Iron Steel Inst. Symposium on Powder Metallurgy, Special Rep. No. 38, 1947, 191–202*).—A survey of modern German developments in the production of metal powders, sintered components, and other products. Researches undertaken are reviewed, and the types of equipment used for pressing and sintering are described. Large quantities of pyrophoric aluminium flake and of iron powder were produced, the latter by disc- and air-atomization processes. Molybdenum powder of greater purity was obtained by distillation of the oxide before reduction. Technical advances in die design and press design are discussed, and the types of component produced are illustrated. 20 references are given, and in an Appendix some 155 references to powder metallurgy in B.I.O.S. and C.I.O.S. reports are alphabetically indexed.—G. V. R.

Discussion on a Symposium on Powder Metallurgy. — (*J. Iron Steel Inst.*, 1947, 157, (4), 537–579).—Cf. preceding abstracts.—R. W. R.

German Production and Use of Boron Carbide and Titanium Boride. — (*Indust. Diamond Rev.*, 1947, [N.S.], 7, (84), 343–344).—A summary of B.I.O.S. Final Report No. 925.—R. W. R.

Copper-Base Powder-Metallurgy Parts. Herbert Chase (*Machines et Métaux*, 1947, 31, (352), 404).—See *Met. Abs.*, this vol., p. 37.—J. L. T.

***On Some New Processes in Powder Metallurgy [of Iron and Aluminium].** Günter Wassermann (*Metallforschung*, 1947, 2, (5), 129–137).—Generally, articles produced by the pressing and sintering of metal powders have heights which are comparable to their cross-sections. Three new methods of production are described, the first two of which overcome this limitation: (1) The production of long tubes by taking iron rings, produced separately, coating their contact surfaces with a thick suspension of iron powder in water, stacking them under light loads (~ 0.013 kg./cm.²), and sintering in an atmosphere of hydrogen for 3 hr. at 1000° C. (2) The production of long bars or tubes by filling iron or aluminium tubes with metal powders, closing the ends, drawing through dies, sintering and, if required, removing the outer cover. The process can be used for iron (with 10% lead and 2% graphite), iron with 20% aluminium, and aluminium powder. Typical reductions are from 23.6 to 22.0 mm. dia. in two passes, using an intermediate anneal of 15 min. at 450° C., and finally sintering in hydrogen for 68 hr. at 630° C. for aluminium and 5 hr. at 1200° C. for iron. (3) The formation of iron bushes, with or without flanges, by the hot pressing of sintered compacts. The products have a fine, uniform crystal structure, and those produced by the third method are very dense, have exceptionally good mechanical properties, and will withstand severe shock conditions.—E. N.

†Introduction to Seminar—Review of Literature on Pressing of Metal Powders. Richard Paul Seelig (*Metals Technol.*, 1947, 14, (5); *A.I.M.M.E. Tech. Publ. No. 2236*, 29 pp. (including Seminar)).—A general review is given of published information on pressing of metal powders at room temp. Only those operations are considered which occur between the time the powder is filled into the cavity and the compact is ejected from the die. The papers are grouped under the headings of experimental and theoretical approach, and properties of compacts (particularly density distribution). The necessity for a composite theory including the effect of many factors is emphasized.

S. considers that attention should be paid to the effect of the vacuum produced when air and other gases are expelled from the interfaces between contacting particles. A bibliography of 65 papers is included.—W. H.-R.

VI.—CORROSION AND RELATED PHENOMENA

***Heavy-Metal Inserts [in Magnesium and Aluminium Alloys] and Corrosion.** A. J. Ferko (*Light Metals*, 1947, 10, (115), 418–421).—This account of work at the Boeing Aircraft Co. deals with bimetallic corrosion of magnesium and of aluminium alloys induced by the presence of heavy-metal inserts. For magnesium alloys, the least harmful insert is said to be "Oilite" bronze. For aluminium alloys, the whole assembly of light alloy plus insert cannot be anodized; it can, however, be given the "Alrok" treatment (said to resemble the M.B.V. process), and test data show that this is approx. as effective as anodizing.—F. A. F.

***On the Influence of Mercury on the Tensile [and Corrosion] Properties of Magnesium-Manganese Alloys.** (Bulian). See p. 333.

***On the Neutralization of the Electrolyte in Leclanché-Type Cells [and the Corrosion of the Zinc Pole].** C. Drotschmann (*Arch. Metallkunde*, 1947, 1, (4), 187–188).—A study was made of the performance of the cell and the rate and uniformity of the corrosion of the zinc pole in Leclanché cells using an aqueous electrolyte containing ammonium, zinc, and mercuric chlorides, whose pH was altered from 4.5 to 6.5 by the addition of various bases. From the viewpoint of actual cell performance the best results were obtained by neutralization with ammonium hydroxide, followed by calcium oxide and zinc oxide, whose depolarization action, however, became less reliable the longer the period of cell discharge. Magnesium oxide had a deleterious effect; it caused a slimy film of magnesium salts to be formed on the zinc which finally led to interruption of the current. Examination of the zinc pole after a discharge of 2.2 amp.hr. showed that the un-neutralized electrolyte had exerted the least corrosion effects on the zinc surface, followed by magnesium oxide, ammonium hydroxide, and calcium oxide; zinc oxide caused the greatest corrosion.—E. N.

***Chimney-Liner Corrosion Resulting from Gas-Fired Furnaces.** George B. Johnson (*Corrosion*, 1948, 4, (1), 15–23).—A survey of reported cases of corrosion of chimney liners, over a period of about 20 years, is reported. After 1944, aluminium liners were usually used, and complaints began to be received in 1946. Investigation showed that all inside corrosion occurred in converted hot-water boilers, generally at the bottom of the tee, due to foreign matter, and that outside corrosion was due to soot, or contact with iron pipes or mortar. Laboratory tests proved that the scale had a high iron content, and accelerated corrosion tests confirmed that the scale could have been a contributory factor.—M. A. V.

Utilization of Electrically Insulated Couplings in Corrosion Control. W. F. Levert (*Corrosion*, 1948, 4, (1), 24–28).—A review of recent progress and developments.—M. A. V.

Mechanical-Design Features of Insulated Couplings. Paul Williams (*Corrosion*, 1948, 4, (1), 29–31).—Cf. preceding abstract.—M. A. V.

Recent Developments on the Use of Corrosion Inhibitors. Jay T. Nicholson (*Corrosion*, 1948, 4, (1), 32–36).—A simple laboratory test apparatus, simulating pipe-line conditions, for determining the efficacy of inhibitors, is described. The factors influencing the choice of inhibitor (polyphosphate, chromate, silicate, chromate-phenol, amine, sulphite, or organic) are discussed.

—M. A. V.

VII.—PROTECTION

(Other than by Electrodeposition.)

Glycerine in Electrolytic Treatment of Aluminium and Its Alloys. Georgia Leffingwell and Milton A. Lesser (*Products Finishing*, 1947, 12, (2), 36, 38, 40, 42, 44, 46).—A comprehensive review of the uses of glycerine in this application. 22 references are given.—G. T. C.

***“Protalization”; a Simple Chemical Treatment of Light-Alloy Surfaces.** E. Jaudon (*Rev. Aluminium*, 1947, (134), 199).—A brief account of corrosion-test results on aluminium and Duralumin specimens submitted to saline mist.—F. A. F.

Passivating Treatments May Improve Cadmium-Plate Coatings. Allen G. Gray (*Products Finishing*, 1947, 11, (10), 60–62).—A brief note giving details of a suitable solution for passivating cadmium coatings.—G. T. C.

Acid Dichromate Treatment for Magnesium Alloys. George Black (*Products Finishing*, 1947, 11, (10), 42–44, 46).—Details of solution composition, operating conditions, and preparation of the work are given.—G. T. C.

Electroless Plating [of Nickel and Cobalt] on Metals by Chemical Reduction. — (*Chem. Eng. News*, 1947, 25, (31), 2222).—A note on the deposition of nickel and cobalt on metallic surfaces by the reduction of nickel or cobalt salts with hypophosphite in hot solutions ($>90^{\circ}\text{C}$). Cobalt and cobalt-nickel alloys are obtained from ammoniacal solutions; nickel from either acid or alkaline solutions. The reaction is catalytic and is only initiated by the introduction of iron or steel, nickel, gold, cobalt, palladium, or aluminium into the solution.—H. A. H.

Hot-Dip Tinning on Coiled Strip [Sherman Process]. — (*Tin Printer*, 1947, 23, (266), 12–13).—A brief description of the Sherman process for the continuous hot-dip coating of tin on coiled steel strip. The strip is uncoiled from a drum, passed successively through pickling baths and water baths, and then is passed through a heating chamber prior to entering a bath of molten tin. After leaving the tin-bath, the strip passes through two spraying devices designed to remove excess plating material from the strip, and is finally coiled on a motor-driven drum. Details of the operation of the plant are given, and it is claimed that a greater rate of output is obtained at a lower production cost than when using older processes. Accurate control of the thickness and uniformity of the coating is possible and the “drip-edge” effect is eliminated.—G. V. R.

Application of Zinc Coatings by Hot Dipping. Robert Steele (*Metal Finishing*, 1947, 45, (12), 71–76).—A review of the whole field of galvanizing. Equipment for pickling and galvanizing is described, and the character of the coating and the influence of the base metal briefly examined. Reference is made to the spelter bath containing small amounts of lead, tin, iron, cadmium, copper, or aluminium.—G. T. C.

Automatic Hot Zinc Galvanizing May Show Advantages in Production Units. Allen G. Gray (*Products Finishing*, 1947, 12, (2), 60–62).—Cf. *Met. Abs.*, this vol., p. 42. A review.—G. T. C.

***Metallography of Hot-Dipped Galvanized Coatings.** (Rowland). See p. 337.

Chemically Generated Film Aids in Corrosion Control [for Zinc and Cadmium]. — (*Steel*, 1947, 120, (22), 101–102, 144).—The properties of “Iridite” films on zinc and cadmium are described.—M. A. V.

Recent Developments in the Use of Conversion Coatings on Zinc-Plated Steel. Allen G. Gray (*Products Finishing*, 1947, 12, (2), 50, 52, 54, 56, 58, 60).—A detailed review of a paper presented by J. E. Stareck and W. S. Cibulskis to the 34th Annual Convention of the American Electroplaters' Society.—G. T. C.

Application of Metallic Coatings [—I, —II]. Rick Mansell (*Metal Finishing*, 1947, 45, (5), 62-65; (6), 91-94).—(I.—) Corrosion and cleaning are briefly considered. (II.—) M. deals with sand blasting, polishing, and the formation of metallic coatings by electrodeposition, metal spraying, cementation, cladding, &c.—G. T. C.

Factors in the Selection of Protective Coatings. Allen G. Gray (*Products Finishing*, 1947, 12, (1), 70, 72, 74, 76, 78).—A review of a paper presented by C. G. Compton to the Protective Coatings Division, Spring Regional Conference of the Chemical Institute of Canada. The fundamental mechanism of corrosion is briefly surveyed and the basic properties of various types of protective coating considered.—G. T. C.

Corrosion Prevention by Sprayed Coatings. H. W. Greenwood (*Mech. World*, 1947, 122, (3177), 596-598).—An elementary review of the flame-spraying metallization process and of its value as an anti-corrosion treatment. Mention is made of flame-sprayed plastic coatings.—R. W. R.

VIII.—ELECTRODEPOSITION

Proper Racking Important in Plating on Aluminium. Allen G. Gray (*Products Finishing*, 1947, 11, (10), 70-71).—A brief account emphasizing the importance of good contact between racks and work when plating aluminium. Metals for constructing racks are compared.—G. T. C.

Electroplating of Aluminium (Preparation by Zinc-Immersion Process). Myron B. Diggin (*Metal Finishing*, 1947, 45, (11), 67-69).—D. describes fully the zinc-immersion process for preparing aluminium and its alloys for electrodeposition. The method is suitable for use with both wrought and cast alloys and is less critical than either oxalic or phosphoric anodizing methods. Brief details are given for subsequent plating with copper, nickel, cadmium, zinc, brass, silver, and copper.—G. T. C.

Determination of Adhesion of Plated Coatings on Aluminium. Allen G. Gray (*Products Finishing*, 1947, 12, (2), 70, 72).—A description, including photographs, of an adhesion-testing apparatus developed by R. A. Ehrhardt and J. M. Guthrie (cf. *Met. Abs.*, this vol., p. 13).—G. T. C.

Discoloration of Cadmium Plate. Allen G. Gray (*Products Finishing*, 1947, 11, (9), 104, 106).—A brief explanation of the discoloration of cadmium plate and methods of overcoming it.—G. T. C.

Production Efficiency in Decorative Chromium Plating Requires Correct Equipment. Allen G. Gray (*Products Finishing*, 1947, 11, (9), 88-92).—Equipment necessary for decorative chromium plating is briefly described. Details of a system of temp. control for the plating bath are given.—G. T. C.

Metal Surfacing by Hard Chromium Plating. Edwin H. Halvorsen (*Metal Finishing*, 1947, 45, (7), 71-76).—An elementary review of the use of hard chromium plating, with particular reference to its use on cutting tools. The properties of the coating are compared with those of other cutting-tool materials. Details are given of tests carried out on plated and unplated gear-shaper cutters. These indicate that the chromium plate, less than 0.0001 in. thick, greatly improved the life of the cutters and permitted faster machining operations and heavier feeds.—G. T. C.

Importance of Chromium Plating Under Conditions of Optimum Throwing Power. Allen G. Gray (*Products Finishing*, 1947, 11, (11), 50-56).—A general account of the operation of chromium-plating solutions, with particular reference to throwing power and its measurement.—G. T. C.

Principles of Electrodeposition: The Copper Sulphate Solution. — (*Electrotypers' and Stereotypers' J.*, 1947, 11, (10), 208; (11), 228-229; (12), 238-239; 12, (1), 14-15; (2), 38-39; (5), 118-119; (6), 141-142).—An elementary review.—W. G. A.

Practical Copper Reduction on Non-Conductors [Prior to Electrodeposition]. Harold Narcus (*Metal Finishing*, 1947, 45, (9), 64-67, 70).—N. describes a commercially applicable method of depositing copper films on non-metals as a preliminary to electrodeposition. The method is suitable for glass and similar materials and also for synthetic resins. The process consists of five steps: (1) the "de-glazing" operation, in which the surface is slightly roughened with abrasive or chemical etching; (2) cleaning; (3) sensitizing the surface by immersion for 1-2 min. in a weak titanium sulphate solution in the presence of hydrochloric acid or sulphuric acid; (4) after thorough rinsing, an "activating" treatment is carried out by immersion for 5 min. in a solution containing 1 g./gal. of chloroplatinic acid in water; (5) the formation of the copper film by immersion in Fehling's solution and reduction by means of a metallo-organic derivative of sodium hydrosulphite (nature not disclosed). The articles are then plated in an ordinary copper-plating bath. Several advantages are claimed for this method over the usual deposition of silver as a conducting coat in the plating of non-metals. Among these are that it is cheaper, that adhesion is better, that there is no risk of explosion as with silver solutions, that the thickness of the copper film is greater than that of the silver film, and that there is no sludge formation.—G. T. C.

Electroplating Non-Conductors. Thomas A. Dickinson (*Metal Finishing*, 1947, 45, (6), 95).—A brief note. Suitable plating solutions are detailed.

—G. T. C.

Practical Methods in Heavy Industrial Nickel Plating. E. J. Roehl (*Metal Finishing*, 1947, 45, (5), 56-59, 71).—Some industrial applications of heavy nickel plating are reviewed and details given of the mechanical properties of nickel deposits from three types of bath, namely Watts', chloride, and hard-nickel. The composition of the three baths is included and operating conditions specified. Information on the cleaning and etching of the work before plating and on machining after plating is listed.—G. T. C.

Chevrolet Increases Nickel Plating on Bumpers. Larry Strong and H. F. Reves (*Products Finishing*, 1947, 11, (11), 20-22, 24, 26).—S. and R. describe car-bumper production and finishing in general terms. The thickness of nickel now being used is three times that used during the war.—G. T. C.

***Determination of Silver and Copper in One Sample of Plating Solution** (Silverman). See p. 355.

Electrodeposition of Tungsten Alloys. — (*Chem. Eng. News*, 1947, 25, (48), 3590).—A note on the processes developed at the National Bureau of Standards, Washington, for the electrodeposition of cobalt-, nickel-, and iron-tungsten alloys, together with a brief survey of the composition and physical properties of the alloys. A typical solution operating at 90° C. with a c.d. of 2-5 amp./dm.² for depositing cobalt-tungsten contains: tungsten (as sodium tungstate) 25, cobalt (as cobalt chloride or sulphate) 25, Rochelle salt 400, ammonium chloride 50 g./l., and ammonia to pH 8.5-9.—H. A. H.

Alloys by Electrodeposition. J. B. Mohler and H. J. Sedusky (*Metal Finishing*, 1947, 45, (12), 65-70).—A summary of the general principles of alloy plating. The properties of the deposit are briefly considered.—G. T. C.

Industrial Plating of Zinc-Base Die-Castings. Charles Temple (*Metal Finishing*, 1947, 45, (7), 82-83).—A brief account of the plating of zinc-base die-castings with copper, nickel, and chromium. Full details are not given.

—G. T. C.

Plated Zinc-Base Die-Castings. E. J. Roehl (*Metal Finishing*, 1947, 45, (10), 63-67).—A review of up-to-date methods of plating zinc-base die-castings. Plating specifications, and the influence of design on the ease of application of the deposit, are examined. Details are set out of methods of surface preparation and cleaning and of the plating solutions for still-vat and barrel

plating. Bath contamination and stripping of deposits are discussed, and formulae of baths for the latter operation are given.—G. T. C.

***Surface-Texture Study of Electroplated Zinc.** R. L. Lunt (*Metal Finishing*, 1947, 45, (8), 68–69).—A number of photomicrographs, at 200 magnifications, of zinc coatings from an acid bath are shown. All the coatings are on strip steel. It is claimed that these show that the internal grain structure of the anode has a direct influence on the surface texture of the deposit and that this surface texture is not a function of the cathode surface texture alone. Relative movement of anode and cathode improves the surface texture of the deposit.—G. T. C.

Metallography for the Electroplater [—II]. Alex Blazy and J. B. Mohler (*Metal Finishing*, 1947, 45, (5), 68–71).—Cf. *Met. Abs.*, this vol., p. 17. The interpretation of photomicrographs of electrodeposited coatings is briefly considered. A list of etching reagents for various metals is given.—G. T. C.

Introductory Survey of Electroplating [—I, —II]. Rick Mansell (*Metal Finishing*, 1947, 45, (11), 70–74; (12), 79–81).—(I.—) An elementary account, dealing with the function of electroplated coatings and their properties and with bath characteristics. (II.—) M. considers electrical equipment, materials for making vats, and applications of various types of coating.—G. T. C.

Reducing Hydrogen Embrittlement in Electroplating. Allen G. Gray (*Products Finishing*, 1947, 11, (10), 64–66).—A brief review.—G. T. C.

Consulting the Floor Doctor [for Electroplating Shops]. George Black (*Metal Finishing*, 1947, 45, (12), 62–64, 76).—A survey of the various types of flooring suitable for electroplating shops. Brick, concrete, asphalt mastic, and wood deck over tar, felt, and slag roof floors are considered briefly.—G. T. C.

Engineering a Small Job-Plating Shop. A. Lakos (*Metal Finishing*, 1947, 45, (7), 69–70, 89).—Several small mechanical devices designed to facilitate work in the small plating shop are described briefly.—G. T. C.

High-Production Job-Shop Plating. Louis J. Donroe (*Metal Finishing*, 1947, 45, (9), 71–74).—Plating procedures are described for automatic and semi-automatic plating equipment. Details are given for plating on brass and steel, zinc-base die-castings, stainless steel, and Monel metal.—G. T. C.

Activated-Carbon Purification of Plating Solutions. Allen G. Gray (*Products Finishing*, 1947, 12, (1), 80–84).—A review of a part of a paper presented by B. C. Case to the 34th Annual Convention of the American Electroplaters' Society, entitled "Modern Application of Electroplating-Solution Purification".—G. T. C.

Rectifiers for Electroplating.—III, —IV. Louis W. Reinken (*Metal Finishing*, 1947, 45, (5), 72–74, 77; (6), 88–90; (9), 75–78).—Cf. *Met. Abs.*, this vol., p. 17. (III.—) An elementary discussion of theoretical and practical considerations involved in connecting two or more rectifiers in series and in parallel. R. describes in general terms the advantages of multi-output rectifiers, and goes on to mention the use of series-connected rectifiers in chromic acid anodizing. (IV.—) An elementary account of various auxiliary mechanisms for rectifier equipment, namely on-off control, and protective devices to guard against abnormally high temp. due to ventilation failures, unusual local temp. conditions, and load current in excess of the rectifier rating. Meters are also mentioned. Automatic control of time and of ampere-hours is briefly considered.—G. T. C.

Largest Automatic Plating Plant in the World. — (*Metal Finishing*, 1947, 45, (7), 67–68).—A description of a fully automatic plating plant consisting of three sections for copper, nickel, and chromium plating. Data are shown for dimensions, current requirements, &c., but not for the solutions used.—G. T. C.

Plating Methods at Gerity-Michigan Plants. W. T. Walsh (*Products Finishing*, 1947, 11, (8), 28-30, 32, 34, 36, 38, 40, 42, 44).—G. T. C.

Fluid Mechanics: Forgotten Factor in Electroplating. Joseph B. Kushner (*Metal Finishing*, 1947, 45, (10), 72-74).—K. describes briefly the application of fluid mechanics to plating and considers the possible advantages of plating under pressure. These are: (1) increased pressure would give more effective wetting action; (2) it would lead to higher cathode and anode efficiencies; (3) conductivity would be increased in many solutions; (4) much higher temp. could be used than at present; and (5) smoother deposits would be produced.—G. T. C.

Quality Plating Demands Consideration of Metal-Distribution Factors. Allen G. Gray (*Products Finishing*, 1947, 12, (1), 86-90).—Some factors influencing metal distribution from plating baths and how they affect plating quality are reviewed.—G. T. C.

Barrel-Plated Multiple Coatings. Mario Mazzone and Floyd McKnight (*Metal Finishing*, 1947, 45, (6), 81-85).—A description of a large barrel-plating plant carrying out copper, nickel, chromium, zinc, cadmium, and silver plating as well as black oxidizing. Details of solutions used and of operating conditions are included for some of these processes. The use of barrels for chromium plating is of interest. The authors consider briefly the type of barrel used and the limitations of the method in this case.—G. T. C.

Pre-Treatment for Barrel Plating. (Mazzone and McKnight). See p. 371.

Electroplating Control Laboratory [—I, —II]. H. J. Sedusky and J. B. Mohler (*Metal Finishing*, 1947, 45, (9), 60-63; (10), 68-71, 74).—(I.—) S. and M. discuss the apparatus that is necessary in a control laboratory. Glassware, balances, and electrical equipment are mentioned. (II.—) Various electrical instruments are considered and small-scale plating equipment described.—G. T. C.

Rapid Plating-Range Test. J. B. Mohler (*Iron Age*, 1947, 160, (23), 75-76).—If a plating current is allowed to pass through a slot, the fall in c.d. along the cathode will vary logarithmically as the distance from the slot. This principle forms the basis of a rapid, practical plating-range test for chromium acid baths, giving the control in chromate: sulphate ion ratio without continual chemical analyses. The test may also be applied to chromate baths using catalysts other than sulphuric acid.—J. H. W.

Common Plating-Bath Troubles—Their Causes and Cures. J. B. Mohler (*Iron Age*, 1947, 160, (24), 98-101, 170).—M. describes the causes of the commoner plating-bath troubles and the procedures to be adopted to correct or obviate them. Such troubles are rough, burnt, off-colour, peeled, brittle, cracked, blistered, spotty, and pitted deposits. He describes testing and control methods, both general and specific, and a continuous purification procedure.—J. H. W.

Engineering Applications of Electrodeposited Coatings. Myron B. Diggins (*Metal Finishing*, 1947, 45, (6), 78-80).—D. reviews the engineering applications of chromium, nickel, iron, copper, tin, and precious-metal plating.—G. T. C.

Toxicity of Chemicals in Electroplating [—I, —II, —III]. P. M. Van Arsdell (*Metal Finishing*, 1947, 45, (8), 55-60, 67; (9), 79-83; (10), 75-81).—(I.—) Toxic reactions to the chemicals used in electrodeposition are examined under the following headings: aluminium and its salts, ammonium hydroxide and ammonium salts, antimony and its salts, arsenic, boron compounds, cadmium and its salts, and chromium and chromium compounds. Brief mention is made of the symptoms in each case. 79 references are given. (II.—) A further list of chemicals and symptoms is considered, including cobalt compounds, copper and copper salts, gold compounds, iron and the ferric salts, lead and its salts, mercuric salts, nickel and its salts, rhodium, platinum, and palladium. (III.—) Van A. discusses the toxic effects of: silver and its salts.

iron and its salts, zinc and its salts, acids, alkalis, cyanides, sulphides, sulphates, oxalic acid, hydrofluoric acid, fluosilicates, and fluoborates. All the information given is summarized in a table.—G. T. C.

IX.—ELECTROMETALLURGY AND ELECTROCHEMISTRY

(Other than Electrodeposition.)

Some Problems in the Sphere of the Production of Electric Currents by Primary and Secondary Cells. Friedrich Müller (*Arch. Metallkunde*, 1947, 1, (4), 145–147).—M. reviews the electrochemical processes at the poles, the choice of suitable materials for the construction, and the corrosion which occurs, in primary and secondary cells.—E. N.

The Principle of the Lead Accumulator. C. Drotschmann (*Arch. Metallkunde*, 1947, 1, (4), 148–159).—A review.—E. N.

XI.—ANALYSIS

Quantometer Speeds Aluminium Alloy Analyses. T. S. Blair (*Iron Age*, 1947, 160, (25), 65–67, 135).—The Quantometer is a special direct-reading spectrometer, and is said to be capable of 5-min. analyses of Al casting alloys on a production basis.—J. H. W.

On Some Reactions of the Ions of the Aluminium Group. G. Charlot (*Anal. Chim. Acta*, 1947, 1, (4), 218–248).—[In French]. The reactions of the following reagents with the metals of the Al group are described in some detail: (1) "Aluminon", (2) various derivatives of oxyanthraquinone, (3) cochineal and carminic acid, (4) morine, (5) hæmatoxylin, (6) various xy-azo dyes, and (7) polyphenols and oxy-acids. In many instances estimates are given of the limits of detection. A highly specific and sensitive test for Al^{3+} and Ga^{3+} is the red fluorescence produced with Chrome Blue 2R; a similar reaction for Be^{2+} is that with an alcoholic solution of morine in an alkaline medium; a yellow fluorescence is produced, which is best viewed by ultra-violet light. Other reactions of importance are Zr^{4+} with morine and hæmatoxylin, Ti^{4+} with resorflavine, and Be^{3+} with quinizarine and with 1-amino-4-oxyanthraquinone. C. also discusses the precipitation of the metals of the Al group by arsenic and phosphoric acids and by some organic derivatives of As. Methods of separating Al^{3+} and Ga^{3+} , prior to detection of these elements, are suggested: (1) a quantitative separation of Al^{3+} by reaction with cupferron in acid medium with subsequent extraction of Ga^{3+} and other interfering ions by ethyl acetate, and (2) separation of Ga^{3+} from large amounts of Al^{3+} by extraction of Ga oxinate by chloroform at pH 2.0.—R. W. R.

***Properties of Oxinates of Aluminium, Gallium, and Indium. Separation of Gallium by Extraction with Chloroform.** S. Lacroix (*Anal. Chim. Acta*, 1947, 1, (4), 260–290).—[In French]. Cf. preceding abstract. L. discusses the acidic properties of oxine and the extraction by chloroform of this substance; 100% extraction is obtained in the pH range 4–11. Studies are reported of the properties (in particular the neutralization by alkalis) and extraction by chloroform of the oxinates of Al, Ga, and In. Extraction of Al oxinate is 99% complete at pH >4.5, that of Ga oxinate 100% complete at pH >2, while that of In oxinate is 100% complete at pH >3. Calculated and experimentally verified extraction curves are given which show that, at pH 2.0, while extraction of Ga oxinate is complete, that of Al oxinate is negligible; separation of 1 part of Ga^{3+} from 10^4 parts Al^{3+} is therefore possible by extraction with chloroform at pH 2.0. The extraction by chloroform also enables Al^{3+} , Ga^{3+} , and In^{3+} to be determined by acid titration.

Free acid in the solution is first determined by titration with $N/10$ -NaOH in the presence of K oxalate, using bromothymol blue as indicator. Chloroform, oxine, and bromothymol blue are added to a second litre of the unknown solution, which is immediately titrated with excess $N/10$ -NaOH until a green precipitate appears. The mixture is then shaken until the aqueous layer is clear, and the excess NaOH in the aqueous layer is determined by back titration with $N/10$ -HCl. A potentiometric titration is also possible.—R. W. R.

***Methylfluorone, a Special Reagent for Antimony.** J. Gillis, J. Hoste, and A. Claeys (*Anal. Chim. Acta*, 1947, **1**, (4), 291–301).—[In French]. The authors discuss the properties, preparation, and purification of methylfluorone (9-methyl-2:3:7-trihydroxy-6-fluorone), a reagent originally introduced by Wenger, Duckert, and Blancpain (*Mikrochim. Acta*, 1938, **3**, 13). Purity is best controlled by the m.p. of the acetyl derivative (222.5° – 224° C.). The pure product is stable in the solid state, but not in ethyl alcohol; its solubility in alcohol is very small (0.095%). A filter-paper test is preferred to other methods; a filter paper impregnated with a drop of the saturated alcoholic solution gives a colour change from yellow to red with Sb and Mo, while Ge and Sn produce an orange coloration. The sharpness of the reaction with Sb and Mo is increased by using an acid (1N) alcoholic solution of the reagent. The reaction may be made specific for Sb by treating the spot with a few drops of $H_2O_2 + HCl$, when the coloration due to Mo disappears. The test will detect 1 part of Sb in 250,000. Curves are given which show the effect of various other metal ions on the sensitivity of the reaction. A table is presented which shows the reactions of the reagent in 3 different solutions, with 60 metal ions.—R. W. R.

***Detection of Cerium by Means of Oxidation-Reduction Indicators.** G. Charlot (*Anal. Chim. Acta*, 1947, **1**, (4), 309–313).—[In French]. A study was made of various indicators, oxidizable by Ce^{4+} , and which might be employed for the detection of Ce^{4+} . The best reagent of those examined was found to be N -phenylanthranilic acid (the Na salt is used), which is oxidized by Ce^{4+} to yield a purple coloration. The reaction is specific for Ce^{4+} among the rare earths, but other strong oxidizing agents (e.g. Mn, Cr, &c.) give the same coloration.—R. W. R.

***A Specific Reagent for Germanium: Phenylfluorone.** J. Gillis, J. Hoste, and A. Claeys (*Anal. Chim. Acta*, 1947, **1**, (4), 302–308).—[In French]. The authors discuss the detection of Ge^{4+} with methylfluorone and point out that it is necessary to treat with 6N-HCl to make the reaction specific. A better test is afforded by the use of phenylfluorone (9-phenyl-2:3:7-trioxy-6-fluorone). A drop of an acidified 0.05% alcoholic solution of the reagent is placed on a filter paper which is allowed to dry. A drop of the unknown solution, previously acidified with HCl (3–6N), is placed on the reagent spot. On addition of a few drops of 6N- HNO_3 , a colour change from yellow to red occurs if Ge^{4+} is present. The reaction is specific for Ge^{4+} and will detect 1 part in 30,000. The only interfering ions are those of strong oxidizing agents (Ce^{4+} , Cr^{6+} , Mn^{7+} , &c.), which must first be eliminated. Details of the preparation of the reagent and of its reactions with 60 metal ions are given.—R. W. R.

***Qualitative Semi-Micro-Analysis with Reference to Noyes and Bray's System: Partial Analysis of the Combined Nickel, Zirconium, and Rare-Earth Groups.** Christina C. Miller (*J. Chem. Soc.*, 1947, (Oct.), 1347–1350).—Cf. *Met. Abs.*, 1944, **11**, 156. A scheme for the detection and approximate determination of Mn, Co, Ni, Ti, Zr, Zn, In, and Sc in solutions containing a maximum of 50 mg. of these metals in the presence of Th, Y, Ce, La, Nd, and Pr. The max. amount of any one rare-earth-group metal is 10 mg. Using separate samples of the solution, 0.25–50 mg. of Mn, Co, or Ni are detected by potassium periodate, ammonium thiocyanate and extraction with butyl

etate, and dimethylglyoxime, respectively; and 0.25–10 mg. of Ti and Zr chromotropic acid and *p*-hydroxyphenylarsenic acid, respectively. After separation from Co and >1 mg. of Ni, Zn is detected in a further sample by copper sulphate and ammonium mercury thiocyanate. 0.25–10 mg. of In or are isolated in the last portion, the former by precipitation as sulphide and confirmation with alizarin, the latter by alizarin-S or morin. The validity of the method was tested by analysing 8 mixtures containing 0.5 mg. each of Fe, Ga, Al, and V as contaminants.—H. A. H.

***Determination of Silver and Copper in One Sample of Plating Solution.** Louis Silverman (*Metal Finishing*, 1947, 45, (11), 80–82).—S. discusses the limitations of the ordinary thiosulphate titration for Cu, and points out the improvement obtained by using sodium thiocyanate during the titration to remove the CuI formed, and the desirability of adding ammonium bifluoride. Fe is present in order to prevent ferric salts reacting with KI. A method is given for determining Ag and Cu in the same solution as follows: 10 ml. of solution are evaporated to fumes with 10 ml. HNO₃ and 10 ml. H₂SO₄. After cooling, 50 ml. water and 2 ml. ferric ammonium sulphate (2% solution) are added and (when cold) titrated with 0.168*N*-sodium thiocyanate to a faint brown colour (ml. NaCNS \times 0.30 = AgCN oz./U.S. gal.). NH₄OH is added until the solution just turns blue or until Fe(OH)₃ is precipitated. After cooling, 8 g. ammonium bifluoride is added. The solution should now have a pH of 3–4. 15 g. solid KI is added and liberates iodine, titrated to a faint brown colour with Na₂S₂O₃. 6 ml. 50% NaCNS and 2 ml. 1% arrowroot starch solution are added and titration continued to the end point (ml. Na₂S₂O₃ \times normality \times 1.19 = CuCN oz. U.S. gal.).—G. T. C.

***Principals and Principles of Spectrochemical Analysis.** William F. Meggers (*Spectrochim. Acta*, 1947, 3, (1), 5–17).—[In English]. An historical review, leading to a consideration of the fundamental principals of spectra in so far as they are relevant to developments of applied spectroscopy. Besides positive suggestions, M. points out the impossibility of extending the method proposed by van Calker (*ibid.*, 1944, 2, 333; *Met. Abs.*, 1945, 12, 405).—E. VAN S.

***The Calculation of Sensitivity [in Spectrochemical Analysis].** H. Kaiser (*Spectrochim. Acta*, 1947, 3, (1), 40–67).—[In German]. The sensitivity of a method of detection of an element in a spectrum is called a sensitivity limit, defined as the concentration at which the intensity of the strongest line of the element has a density $3\sqrt{2}$ times that of the standard deviation of the density measurements of the spectrum lines. A lower limit for the quantitative estimation of the element can also be defined as the concentration at which the blackening of the strongest lines is ten times the standard deviation mentioned above. The method of defining the standard deviation of the density measurements is described in detail, and it is shown to be independent of the photographic exposure provided that the latter suffices to give a minimum background density of 0.2 in the spectrum. The sensitivity limit is a function of the method, the electrical and photographic conditions of exposure, and the instruments used; but it has the advantage of being objectively defined, and can be determined without the preparation of samples containing minimal traces of the element, since its value can be derived by extrapolation from a calibration curve of a certain type.—E. VAN S.

Progress in Analytical Applications of Emission Spectrography in Great Britain During 1945–46. D. M. Smith (*Spectrochim. Acta*, 1947, 3, (1), 89–104).—[In English]. A survey of published work, with a bibliography of 41 references.—E. VAN S.

Spectrography. John Byrt (*Symposium on Recent Advances in Physical Metallurgy, Part 4: Physical Apparatus for Metallurgical Measurements, Australian Inst. Metals (Melbourne Branch) Physical Metallurgy Division*, 1947, 26 pp.).—A general review of the development of spectrography, with

special reference to modern techniques. After a section on sampling and the form of electrodes suitable for various purposes, the flame method, the low-voltage D.C. arc, the A.C. arc, the condensed-spark, the high-frequency-spark, and the triggered-arc methods of excitation are critically discussed, with emphasis on the form of the discharge and the control and stability of conditions. Typical optical systems are dealt with, and the relative merits of quartz prisms and gratings for the dispersion unit are compared. A detailed description is given of photographic recording and the quantitative spectrophotometric interpretation of spectra, and the modern technique of photoelectric recording is considered. General applications of spectrography are given, together with 58 references.—G. V. R.

***Quantitative Spectrographic Analysis of White Metal Using Spark Excitation.** J. Gillis, J. Eeckhout, and M. van Doorselaer (*Anal. Chim. Acta*, 1947, **1**, (4), 209–217).—[In English]. A method is described for the rapid routine spectrographic analysis of a bearing alloy of the composition Sn 83, Sb 11, and Cu 6%, plus the impurities Pb, As, Fe, and Zn. Full details are given of the apparatus and technique employed; condensed spark excitation was used. The intensity ratio between a line of the element to be determined and a line of the base element was expressed as the "efficiency-difference", due to Breckpot (*Spectrochim. Acta*, 1940, **1**, 137; *Met. Abs.*, 1940, **7**, 260), and standard curves are given in which the efficiency-difference is plotted against percentage of alloying element. Estimates are made of the reproducibility and accuracy of the method; the probable error of a single efficiency-ratio is in all cases <0.01 , and the probable error of the determined percentage of alloying element is $<3\%$ for all elements except Zn, for which the error is 16.4% .—R. W. R.

***A Note on the Effect at the Cathode of an Arc Between Copper Electrodes.** (Milbourn). See p. 322.

XII.—LABORATORY APPARATUS, INSTRUMENTS, &c.

(See also "Testing" and "Temperature Measurement and Control".)

Measuring Millionths with New British Measuring Instrument. ——— (*Steel*, 1947, **120**, (22), 114).—A brief account of the "Topograph", manufactured by the David Brown Tool Co., for detecting surface irregularities.—M. A. V.

***Cathode-Ray Recording Micrometer and Force Gauge.** J. Ewles and C. Curry (*J. Sci. Instruments*, 1947, **24**, (10), 261–265).—An apparatus is described using a cathode-ray oscillograph in conjunction with a moving-coil system to record and measure rapidly varying movements of the order of 3 mm. to an accuracy of 0.0025 mm. When attached to a specially designed force gauge the device can be used to measure rapidly varying forces, or rapid shear.—W. H. R.

Dilatometry. N. A. McKinnon (*Symposium on Recent Advances in Physical Metallurgy, Part 4: Physical Apparatus for Metallurgical Measurements. Australian Inst. Metals (Melbourne Branch) Physical Metallurgy Division*, 1947, 27 pp.).—The general principles of dilatometry are explained, and it is pointed out that dilatometer measurements can be made at constant temp., and are useful for the investigation of isothermal transformations, and particularly for the investigation of changes of the type found in iron-manganese and iron-manganese-carbon alloys. The method is less sensitive to impurities than the electrical-conductivity method, but can only be used well below the solidus. Vol. dilatometers are little used. Most methods involve measurements of length changes, using a differential principle and a standard rod. Specimens may be in the form of rod, or, for quick transformations where the cooling rate throughout the section must be uniform, in

the form of tube or strip. Methods of measuring dimensional changes are critically discussed. These involve microscopic observation of fiducial marks, dial gauges used directly or with amplification, direct lever amplification on to a recording chart, hydraulic amplification to a capillary, optical magnification of movement with mirrors or prisms, levers combined with optical magnification, interference techniques, change of capacity in a condenser of which one plate is coupled to the specimen, electric strain-gauges, X-ray measurement of lattice spacings, and changes in electrical characteristics of electronic micro-meter tubes. Advantages and limitations of the various methods are discussed, and examples of apparatus embodying these devices are given. There is a bibliography of 54 references.—G. V. R.

Electronics in Metallurgy. D. Michell and G. W. West (*Symposium on Recent Advances in Physical Metallurgy, Part 4: Physical Apparatus for Metallurgical Measurements. Australian Inst. Metals (Melbourne Branch) Physical Metallurgy Division, 1947, 12 pp.*).—A résumé of basic electronic principles and their application in various fields of metallurgy. The general form and characteristics of typical electron tubes are considered, and their use as rectifiers, amplifiers, and oscillators is described. Specific applications to metallurgy include the measurement by electronic means of changes in dimensions, pressure, vol., and force, and the use of electronic relays and temp.-control devices. Reference is made to photo-electric densitometers, pH meters, conductivity bridges, the recording of magnetic changes, vacuum gauges, and miscellaneous recording and controlling devices. The use of electronic oscillators for induction heating, and the part played by electronics in X-ray tubes and electron microscopes, is referred to.—G. V. R.

***An Instrument for Measuring Particle Diameters and Constructing Histograms from Electron Micrographs.** E. E. Hanson and J. H. Daniel (*J. Appl. Physics, 1947, 18, (5), 439-443*).—An instrument for the semi-automatic recording of the distribution of particle size in the electron micrograph of a dispersed material. The essential features are a motor-driven scanning device, coupled to a screw which bears a mechanism for releasing steel balls into a collecting box having a number of compartments. When a particle is "bracketed" by cross-wires in the scanner, a switch operated by the observer releases a steel ball, which falls into a compartment decided by the size of the particle. The compartments have a diameter slightly greater than that of the balls, and the height to which the compartments are filled at the end of an experiment gives a measure of the frequency of occurrence of the various sizes of particle.—G. V. R.

Spherical Aberration of Compound Magnetic Lenses. L. Marton and K. Bol (*J. Appl. Physics, 1947, 18, (6), 522-529*).—Theoretical. It is shown that reductions in the spherical aberration of strong electron lenses can be effected by using it to form a virtual image, which is transformed into a real image by one or more weak lenses. For two lenses, the image distance is considerably greater than for the strong lens used alone, while a three-lens combination gives a very large image distance. Numerical values of the achieved reduction in spherical aberration are given for different lens-strengths, magnifications, and image distances, and optimum conditions are suggested.—G. V. R.

***Objective Aperture System for the Electron Microscope.** Cecil E. Hall (*J. Appl. Physics, 1947, 18, (6), 588-589*).—An aperture system for use with the R.C.A. type-B electron microscope is described. The advantage over conventional apertures lies in the fact that it is attached to the specimen cartridge rather than to the lens, and hence may be detached and renewed easily. The actual aperture is multiple, and consists of 200-per-inch copper "Lektromesh". Manipulations involved in alignment of the system are described, and examples are given of the added contrast obtainable by the use of the device, when photographing thick specimens. The method may be

usefully applied to dark-field electron microscopy, and reveals interesting features not observed in bright-field work. The occurrence of bright spots at the edges of photographed images of graphite particles is discussed as an example, and it is suggested that these may be due to crystalline reflections by regularities near the surface.—G. V. R.

***A Robust and Inexpensive Microphotometer.** S. C. Baker (*J. Sci. Instruments*, 1947, 24, (10), 275).—A note describing a non-recording microphotometer which was built on a small lathe bed from simple components.

—W. H.-R.

***An Investigation of Photographic Plates for Spectral Analysis.** Per Spiegelberg (*Jernkontorets Ann.*, 1947, 131, (5), 181–191).—[In Swedish, with an English summary]. S. gives a thorough comparison of plates of British, U.S., and Continental origin in respect of the contribution which the plate grain makes to the error of microphotometry, and also of the contrast factor and relative sensitivity in the ultra-violet down to 2800 Å. Eight types of plate are compared, with three developer formulæ, and the results are expressed as standard deviations of the apparent density of an area of 0.0078 mm.² at three density levels. Statistical uniformity varies inversely with sensitivity on the whole, but there is a slight superiority shown by an unusual developer formula, with no loss of contrast.—E. VAN S.

***An Electronic Computer for X-Ray Crystal-Structure Analyses.** R. Pepinsky (*J. Appl. Physics*, 1947, 18, (7), 601–604).—An electronic synthesizer is described for the determination of atomic positions in crystals. The machine sums the two-dimensional Fourier series representing planar, centrosymmetric projections of electron densities in a crystal unit cell, and the projection is presented by a television scan on the screen of a cathode-ray oscilloscope. The specific advantage of the device is the immediate observability of effects on the projection of alterations in sign of one or any number of Fourier coeff.—G. V. R.

***Two Calculating Machines for X-Ray Crystal-Structure Analysis.** A. D. Booth (*J. Appl. Physics*, 1947, 18, (7), 664–666).—Cf. preceding abstract. Two relatively simple mechanisms for the calculation of structure factors in X-ray structure analysis are described. The first is especially useful for tetragonal space groups.—G. V. R.

[Light Alloys] In the Service of Science [—I]. (—) See p. 375.

XIII.—PHYSICAL AND MECHANICAL TESTING, INSPECTION, AND RADIOLOGY

Aspects of the Determination of the Strength of Materials. E. W. J. Mardles (*J. Roy. Aeronaut. Soc.*, 1947, 51, (433), 65–68).—A brief résumé of the papers and discussions at two joint meetings held on 16 June 1945 and 19 February 1946, of the British Rheologists' Club and the Royal Aeronautical Society. The papers include "The Effect of Duration of Loading on the Strength of Brittle Materials", by C. Gurney, and "Application of Statistical Methods to Mechanical-Test Results", by B. Chalmers and E. R. W. Jones.

—H. S.

The Electrical Measurement of Strain. S. C. Redshaw (*J. Roy. Aeronaut. Soc.*, 1946, 50, (428), 568–602; discussion, 603–612).—Strain-gauges of the acoustic, capacity, piezo-electric, variable-inductance, and variable-resistance types are described. The wire resistance strain-gauge and the technique of its use are discussed in detail with special attention to selection of wire for the gauge, methods of gauge manufacture, sensitivity, attachment of gauge to specimen, thermo-electric effects in the wiring system, strain-gauge circuits, calibration, recording, and general operation in various applications connected with aircraft parts.—H. S.

Manufacture of Diamond Tools and Their Application in Germany. — *Indust. Diamond Rev.*, 1947, [N.S.], 7, (84), 334-342; (85), 354-363).—A summary of German practice, based on a number of B.I.O.S. reports and other sources. A section on hardness-testing machine indenters is included.

—R. W. R.

A New Method of Measuring Wear of Machinery Surfaces. F. G. Brickvedde (*Instruments*, 1947, 20, (7), 620-622).—An account is given of the McKee wear gauge, which measures wear in terms of the change in length of a Knoop diamond impression.—J. C. C.

Methods of Testing Metallic Abrasives. J. E. Hurst (*Metallurgia*, 1948, 7, (220), 205-210).—The constitution of chilled-iron shot and grit is described, and methods outlined for determining hardness, density, shape, toughness, crushing index, and grade analysis.—M. A. V.

Crack Detection. — (*Nature*, 1947, 160, (4069), 556-557).—A summary report of a symposium on methods of crack detection held by the Industrial Radiology Group of the Institute of Physics in London. The article includes a short review of contributions on radiographic crack detection; visual, etching, and magnetic methods of detection; and electrical-conductivity and supersonic methods. A brief résumé of the discussion is also given.—G. V. R.

RADIOLOGY

X-Ray Inspection of Aluminium Jet-Engine Castings. W. A. Mader (*Iron Age*, 1947, 160, (24), 90-93).—M. discusses the application of X-ray inspection to complex aluminium alloy castings used in aircraft jet engines, in order to develop the best casting procedures, to act as a guide in the repair of imperfect pieces, and to reduce machine-shop losses due to foundry defects to less than 0.5%.—J. H. W.

***An X-Ray Method of Measuring Poisson's Ratio.** R. F. Hanstock and E. H. Lloyd (*Proc. Inst. Mech. Eng.*, 1947, 157, (26), 52-54; correspondence, 55; and *Engineering*, 1947, 163, (4227), 68-70).—H. and L. describe the measurement of Poisson's ratio in metals by an X-ray diffraction method. A small tensile test-piece is examined at various loads by a high-angle "back-reflection" X-ray technique. X-ray patterns for any load are obtained for various settings of the test-piece relative to the incident X-ray beam, and also, for each setting, the shift of the diffraction lines from their original position gives the strain in a direction normal to the reflecting crystallographic planes. Strains corresponding to various settings of the test-piece for any one load give a linear graph against a simple function of the orientation of the crystallographic planes, and the value of Poisson's ratio is obtained from this graph. Results are quoted for aluminium alloy Hiduminium R.R. 56 giving the value of Poisson's ratio as 0.36. The conclusion is that this method is as accurate as the ordinary mechanical method and that it has the additional advantage of providing values which apply to a single set of crystallographic planes in a polycrystalline metal.—W. A. M. P.

***The Classification and Recording of Spot-Weld Defects Revealed by Radiography.** R. C. McMaster, F. C. Lindvall, and Edythe Dial (*Weld. J. (J. Amer. Weld. Soc.)*, 1947, 26, (2), 121-128).—A procedure for classifying the presence and extent of defects in spot welds revealed by radiography is described. The method involves reference to a series of standards for each of eleven types of defects which may occur. Suggestions for the filing of negatives and examples of the standard charts are given.—P. H.

***Physical Properties of Calcium Tungstate X-Ray Screens.** J. W. Coltman, E. G. Ebbighausen, and W. Altar (*J. Appl. Physics*, 1947, 18, (6), 530-544).—The properties of calcium tungstate X-ray fluorescent screens are fully examined, with reference to the absolute energy of the light emitted, its spectral distribution, and the efficiency of conversion from X-rays to light.—G. V. R.

XIV.—TEMPERATURE MEASUREMENT AND CONTROL

***The Embrittlement of Chromel and Alumel Thermocouple Wires.** W. I. Pumphrey (*J. Iron Steel Inst.*, 1947, 157, (4), 513-514).—P. describes the results of an investigation of the embrittlement which occurred in a 22-S.W.G. Chromel-Alumel thermocouple heated to 800°-825° C. in an uncleaned 18-8 stainless-steel sheath. After 2 hr. at this temp. the couple gave a reading 40° C. low at 659° C. and the Alumel wire was found to be severely attacked and embrittled; the Chromel wire showed only slight attack and no embrittlement. It was noticed that, in the contaminated region, the Chromel wire, which is not normally magnetic, was attracted by a magnet after heating in the sheath. No attack on the couple occurred when the sheath was baked at 800° C. prior to insertion of the thermocouple, but when the sheath was soaked in oil after baking considerable attack occurred, though not to the same extent as with the uncleaned sheath, the Chromel wire remaining non-magnetic. In further experiments, Chromel and Alumel wires were exposed to a mildly oxidizing atmosphere at 800° C. for up to 360 hr. Under these conditions the mode of attack was rather different, no pronounced surface cracking occurring; the attack was again greater on the Alumel wire and the Chromel wire remained non-magnetic. Several photomicrographs of the wires attacked by the various environments are given. P. concludes that the embrittlement is due to the presence of carbonaceous or sulphur-bearing matter and recommends that stainless-steel sheaths be thoroughly cleaned before use.—R. W. R.

The Measurement of Molten Iron and Steel Temperatures. R. G. Ackland (*Symposium on Recent Advances in Physical Metallurgy, Part 4: Physical Apparatus for Metallurgical Measurements. Australian Inst. Metals (Melbourne Branch) Physical Metallurgy Division, 1947, 11 pp.*).—General descriptions are given of the various devices for measuring high temp. as encountered in the iron foundry, and the instruments are critically discussed. Total radiation pyrometers are unsuitable for use unless sighted down a tube which can be immersed in the liquid metal, and fairly elaborate precautions are necessary. A suitable apparatus, embodying a long tube at the hot end of which the radiation receiver is placed and down which gas is forced, is described and illustrated. The limitations of the disappearing-filament optical pyrometer are discussed, with particular reference to changes in emissivity with temp. and composition. The photo-electric pyrometer is referred to, and the characteristics of immersion thermocouples are reviewed. In the tungsten-graphite couple (35 mV. at 1500° C.) the graphite forms the outer tube and is connected to a tungsten rod at the hot end. No sheath is necessary, and the couple is relatively insensitive to cold-junction variations. A similar couple using carbon and silicon carbide has a greater sensitivity (500 mV. at 1500° C.), but is sensitive to cold-junction variations. The graphite tubes tend to dissolve in liquid steel unless further protected with a refractory wash. The modern quick-immersion technique, using platinum/platinum-rhodium couples in thin-walled silica sheaths is described, and suitable quick-response measuring instruments are also dealt with. There is a bibliography of 17 references.—G. V. R.

***Continuous-Control Thermo-Regulator.** P. Wright (*J. Sci. Instruments*, 1947, 24, (10), 258-260).—A continuous-control thermo-regulator of the photo-cell-thyratron type is described in which the controlling influence is applied through a saturated choke. Comparison with an uncontrolled furnace shows that the device reduces temp. fluctuations by a factor of the order of 1/100. Previous work using photo-cells is summarized.—W. H.-R.

XV.—FOUNDRY PRACTICE AND APPLIANCES

Aluminium Alloy Castings [—I]. Floyd A. Lewis (*Foundry*, 1947, 75, (12), 74-77, 186-188, 190).—The discovery of aluminium and the history of its development are briefly described. Descriptions are given of the Hall-Hérault and Bayer processes for the production of aluminium. L. concludes with a brief discussion of alloy selection and with a comparison of sand- and permanent-mould casting.—R. W. R.

Brass and Bronze Foundry Practice. D. Frank O'Connor (*Foundry*, 1947, 75, (3), 105, 172, 174, 176, 178, 180).—O'C. stresses the importance of proper control of operations in brass and bronze foundries and discusses, in an elementary manner, the principal factors requiring such control.—R. W. R.

***The Control of Gas Content During the Melting of Phosphor Bronzes, Gun-Metals, and Leaded Bronzes.** W. T. Pell-Walpole (*Metallurgia*, 1948, 37, (219), 119-128).—The author reviews his own work, and that of Baker and Child, on the degassing of bronzes by oxidizing fluxes, and reports in detail on an investigation carried out to determine the effects of the cupric oxide in the flux, and the gas and phosphorus or zinc content of the charge, on degassing efficiency and oxidation losses. High phosphorus, zinc, or lead bronzes were effectively degassed by melting under oxidizing fluxes, and oxidation losses of phosphorus, zinc, or lead were low. The fluxes used were mixtures of cupric oxide, fused borax, and sand. Phosphor bronzes with phosphorus 0.3-1.5%, of low initial gas content, required a 1:1:1 mixture, or 2:1:1 if the charge were more gassy. Oxidation losses for the respective mixtures were phosphorus 0.3% and tin 0.5%; and phosphorus 0.4-0.5% and tin 0.8-1.0%. Ingoted Admiralty and other gun-metals required a 1:2:2 mixture, and the zinc oxidation loss was 0.2-0.5%. Scrap Admiralty bronze charges of high gas content needed a 2:1:1 mixture, the zinc loss being 0.5-0.7%. Gassy high-zinc gun-metals were deoxidized under a stronger flux (4:1:1), but in an oxidizing atmosphere, a 1:5:5 mixture, or no flux at all, was satisfactory. The zinc loss was 1-1.3% in air or with the strongly oxidizing flux, and 0.3-0.5% with the weak flux. Gassy leaded gun-metal required a 2:1:1 mixture, the zinc loss being 0.5%. Melting in an oxidizing flame gave satisfactory degassing, but oxidation losses were higher (1.5-2%). The tin and lead losses were insignificant. Leaded bronzes, if ingoted, could be melted in an oxidizing flame, or with a weak flux, but gassy scrap charges needed treatment similar to gassy gun-metal. High-lead bronzes (lead 20%, tin 5%) could not be satisfactorily degassed in air; a 2:1:1 mixture was needed. The lead loss was 1-2%, and the tin loss insignificant. In each case the amount of flux used was 2-3% of the charge, and the crucible was thoroughly impregnated with it before use. Additions for oxidation losses were made after removal of the flux. Ingots so obtained were free from harmful porosity and had mechanical properties equal to ingots from degassed virgin melts.—M. A. V.

***Unsoundness Caused by Gases in Copper-Base Alloys.** (Eastwood and Kura). See p. 331.

[Casting of] Magnesium Alloy Doors. R. W. Eade (*Aircraft Prod'n.*, 1947, 9, (110), 466-469).—E. describes the production casting of D.T.D. 59B magnesium alloy fuselage doors for the pressurized fuselage of the Avro Tudor aircraft. The door castings, approx. 6 ft. \times 3 ft. 6 in. with a general wall thickness of $\frac{5}{16}$ in. \pm $\frac{1}{32}$ in., were required with an accuracy on the radius of ± 0.000 , -0.050 in. to match the contour of the fuselage, and they therefore presented a complex manufacturing problem, involving careful construction of the pattern equipment—described in some detail—and a close study of the contraction during cooling in the mould. Melting is carried out in steel crucibles with a protective flux (Melrasel Z); at 750° C. the metal is treated

with hexachlorethane; a second flux (Melrasel E) is then added, and the metal is raised to the casting temp., 790° C. Synthetic sand is used, bonded with bentonite, containing 5% sulphur and 0.5% boric acid. Pouring technique is described. The casting is inspected for dimensional accuracy, subjected to radiographic examination, and then given an annealing heat-treatment for 2 hr. at 330° C. in a built-up steel former to prevent distortion. After further dimensional and contour checking, the casting is finally treated in a chromate bath prior to enamelling.—W. A. M. P.

Casting Zinc Alloy Dies [KirkSITE A]. S. Menton (*Foundry*, 1947, 75, (6), 76–79, 267–269).—M. describes the “open-mould” process for the production of sheet-metal press dies in a zinc-base alloy, KirkSITE A (aluminium 4.25, copper 4, magnesium 1%, zinc remainder). The account covers mould materials and production, melting and casting of the alloy, feeding of the castings, the use of scrap, &c.—R. W. R.

Relation of Mechanical Properties and Internal Stresses to Casting Design. Richard A. Flinn (*Foundry*, 1947, 75, (4), 106–109, 267–268, 270).—F. advocates the use of strain-gauges for measuring the stresses (both applied and internal) present in castings. A knowledge of these stresses enables the casting to be re-designed so as to take most advantage of the known mechanical properties of the material.—R. W. R.

***Why Metal Penetrates Cores and Moulds.** Donald M. Bachelor (*Foundry*, 1947, 75, (6), 80–81, 235, 236, 238).—B. describes tests carried out to elucidate the factors governing the penetration of moulds and cores by molten metal. Moulds containing cores in 7 different sands were poured in cast iron and it was found that penetration increased with the percentage of binder employed; where severe penetration occurred, the sand grains were coated with carbonaceous material. The cause of penetration is therefore ascribed to the decomposition of the organic binders, the carbonaceous material formed prising the sand grains apart. Penetration may be prevented by adding an oxidizing agent (1% iron oxide) to the sand; this oxidizes carbonaceous material to carbon monoxide or dioxide.—R. W. R.

Cores, Sands, and Binders. O. Jay Myers (*Foundry*, 1947, 75, (6), 74–75, 192, 194, 196, 200).—A paper presented at an American Foundrymen's Association Chicago Chapter lecture course. M. discusses core manufacture and the influence, on the properties of the core, of the sand and binder used. A number of recommendations are made.—R. W. R.

Sand Control. George A. Zabel (*Foundry*, 1947, 75, (4), 110–113, 150, 152).—A brief description of the sand-control procedure in use at Z.'s foundry.—R. W. R.

Adopts Chemically Coated Moulding Sand. William G. Gude (*Foundry*, 1947, 75, (5), 66–71).—G. describes the practice of an American iron-foundry using a plastic, “Westonite”, in place of sea-coal in the moulding sand. Advantages of the use of “Westonite” are increased flowability, superior casting finish, rapid mulling, and reduced cost.—R. W. R.

Mould Strength. Harry W. Dietert, H. H. Fairfield, and Edward Hasty (*Foundry*, 1947, 75, (12), 94–95).—The authors emphasize the importance, in routine works control, of the strength of the actual moulds, as opposed to the green compression strength of standard test-pieces prepared in the laboratory, and define a new term “mould strength” as the compressive strength at the mould face. Mould strength is measured with a standard hardness tester, carrying an additional scale reading mould strength in lb./in.² The calibration of the instrument was performed by taking hardness readings on a series of A.F.A. specimens of varying green compression strength; a calibration curve relating mould hardness with strength is given. The relationship of mould hardness to permeability and hot strength of any particular sand is discussed.—R. W. R.

New Lifting Device Simplifies Mould-Weight Handling. William K. Mitchell (*Foundry*, 1947, 75, (3), 146, 148).—M. describes a device, worked by compressed air, for lifting the weights placed on moulds prior to pouring. A single means of moving brass ingots from the delivery trucks to the metal store is also described.—R. W. R.

Ventilating Screens, Breakers, Mullers. — (*Foundry*, 1947, 75, (3), 16-77, 229-231).—A discussion of dust control in sand-preparation plant. Recommendations are made as to the design of ventilating equipment.—R. W. R.

Cutting the Cost of Portable-Tool Operations [in the Foundry]. D. S. Linton (*Foundry*, 1947, 75, (12), 84-87, 212, 214, 216).—Suggestions are made with regard to possible economies in the use of pneumatic grinders, cutters, and other tools used in the fettling of castings.—R. W. R.

Converts Dairy Into Modern Non-Ferrous Foundry. Pat Dwyer (*Foundry*, 1947, 75, (12), 90-93, 204, 206, 208, 210).—D. describes the lay-out and practice of a foundry, making bronze and aluminium castings, which was installed in a building formerly used as a dairy barn.—R. W. R.

1947 Inventory of Foundry Equipment [in U.S.A. and Canada]. — (*Foundry*, 1947, 75, (3), 81-104).—A statistical survey of the age and distribution of foundry equipment in more than 1500 foundries in the U.S.A. and Canada. The study includes data on projected expansions of the industry.—R. W. R.

Importance and Future of the Foundry Industry [in the U.S.A.]. George T. Christopher (*Foundry*, 1947, 75, (6), 85, 160, 163).—C. discusses some current problems facing the foundry industry in the U.S.A.—R. W. R.

Elbow Room in the Foundry? Clement J. Freund (*Foundry*, 1947, 75, (5), 83, 252, 254).—A paper presented to the Western Michigan Chapter of the American Foundrymen's Association. F. discusses the need for and advantages to be gained from research in the foundry.—R. W. R.

Pricing Castings for Profit [—II]. Joseph B. Meier (*Foundry*, 1947, 75, (3), 108-109, 243-248).—Cf. *Met. Abs.*, this vol., p. 298.—R. W. R.

Aluminium Permanent-Mould Castings. E. G. Fahlman (*Light Metal Age*, 1947, 5, (12), 6-12).—The advantages of permanent-mould aluminium castings over sand castings are enumerated and suggestions made as to design and choice of alloy. [Note: A table of properties of "Permold" alloys, referred to in the text, is missing.] Present applications and trends are discussed.—M. A. V.

Pressure-Casting Match-Plates. Edwin Bremer (*Foundry*, 1947, 75, (4), 124-126, 284-286).—B. describes the use of plaster moulds for the manufacture of metal match-plate patterns. Detailed recommendations are made with regard to the handling and baking of the plaster moulds. The match-plate patterns are cast under a pressure of 4-6 lb./in.²—R. W. R.

Pressure Die-Casting Magnesium [Alloys]. J. L. Erickson (*Light Metals*, 1947, 10, (115), 390-395).—After an historical commentary in which he analyses some reasons for early failures in pressure die-casting magnesium alloys, E. deals with some fundamental differences between magnesium and aluminium die-casting alloys, and their practical significance in terms of die-casting technique. As the heat capacity of magnesium alloys is lower, the cold-chamber machines employed must be operated at higher pressures than for aluminium alloys.—F. A. F.

Effect of Alloy Composition on the Surface Quality of [Zinc-Base] Die-Castings. A. W. Sundwick (*Iron Age*, 1947, 160, (23), 71-74).—S. explains the advantages of maintaining the composition of zinc-base die-casting alloys within very narrow limits to ensure optimum castability, and to minimize surface defects and irregularities due to die design. He also describes fluidity and solidification-range tests used as shop-control devices.—J. H. W.

Causes of Die-Casting Irregularities. James L. Erickson (*Iron Age*, 1947, 160, (20), 82-87, 151; (22), 80-86).—E. gives a concise but detailed explanation of the causes of some common die-casting irregularities, and suggests means for eliminating these defects. He explains and illustrates the normal characteristics of die-castings, the effects of pressure, temp., and design, and describes irregularities affecting surface finish, dimensional tolerances, mechanical properties, and machinability.—J. H. W.

Gravity and Pressure Die-Castings Used in the Minilift Portable Hoist. H. K. Barton and L. C. Barton (*Machinery (Lond.)*, 1947, 71, (1827), 495-498).—J. C. C.

Economics of Die-Casting Die Construction. J. L. Erickson and H. K. Barton (*Machinery (Lond.)*, 1947, 71, (1831), 606-609).—The advantages are outlined of built-up dies containing cavity inserts which can be replaced when heat-checked. In multi-cavity dies for small parts, the impressions may readily be hobbled into separate inserts.—J. C. C.

The Lost-Wax Process: Its Application to the Precision Casting of Nickel Alloys. H. Evans, P. S. Cotton, and J. Thexton (*Machinery (Lond.)*, 1947, 70, (1808), 645-650).—Abridged report of a paper read before the Institute of British Foundrymen, 1947. See *Met. Abs.*, this vol., p. 114.—S. G.

XVII.—FURNACES, FUELS, AND REFRACTORY MATERIALS

Developments in Air-Circulated Heat-Treatment Furnaces. C. C. Downie (*Tin Printer*, 1947, 23, (266), 18-19).—The advantages of air circulation in heat-treatment furnaces are discussed, and semi-automatic and fully automatic designs are briefly described.—G. V. R.

†**Phase Diagrams for Ceramists.** F. P. Hall and Herbert Insley (*J. Amer. Ceram. Soc.*, 1947, 30, (11 (2)), i-viii, 1-152).—Cf. *Met. Abs.*, 1938, 5, 354. A revised and enlarged edition of the collection. It consists of 507 diagrams, the majority of which are of systems of oxides, although some of the diagrams refer to systems of halides and other salts; a number of mixed systems is also included. A few diagrams and tables are given which show the optical and temp.-deformation properties of certain systems. The principles of equilibrium diagrams are described in a preface to the collection.—R. W. R.

XVIII.—HEAT-TREATMENT

***Quenching of 75S Aluminium Alloy.** W. L. Fink and L. A. Willey (*Metal Technol.*, 1947, 14, (5); *A.I.M.M.E. Tech. Publ. No. 2225*, 13 pp.).—The properties of a 75S alloy (copper 1.64, manganese 0.16, magnesium 2.58, zinc 5.66, chromium 0.27, remainder aluminium with normal impurities) are sensitive to the rate of quenching. The ultimate tensile strength, yield strength, and resistance to corrosion (3½% sodium chloride alternate-immersion test) were determined for specimens which had been quenched in various ways, including delayed and interrupted quenching. Slow quenching, particularly in the range 750°-550° F. (399°-288° C.), impairs both the tensile properties and the corrosion-resistance. When the average quenching rate through this range exceeds 800° F. (444° C.)/sec., max. strengths and corrosion-resistance are obtained. If the rate lies between 800° and 200° F. (444° and 111° C.)/sec. the strengths are impaired slightly, but the resistance to corrosion is almost unaffected. At rates down to 35° F. (19° C.)/sec. the strengths decrease most rapidly and the resistance to corrosion decreases to a minimum. At still lower rates the strengths decrease very rapidly but the corrosion-resistance improves.—W. H.-R.

*The Influence of a Thermal Pre-Treatment on the Crystal Size of Age-Hardened Sheets of a Duralumin-Type Alloy After Critical Deformation. (Bassi). See p. 336.

*On the Warm Ageing of Aluminium-Zinc-Magnesium Forging Alloys. Walter Bungardt and Viktor Hauk (*Metallforschung*, 1947, 2, (6), 161-168).—A study was made of the age-hardening of five aluminium alloys containing zinc 4.4-4.6, magnesium 1.8-2.65, manganese 0-1.25, silicon 0.10-0.75, iron 0.18-0.32, and copper 0-0.25%, in sheet form. Samples were (1) solution-treated in air ovens or oil baths for 30 min. at 500° C., quenched in cold water, and then aged for (a) 0-1000 hr. at 95°-140° C. and (b) for 24 hr.-30 days at room temp. followed by 0-600 hr. at 100° or 140° C.; and (2) solution-treated for 30 min. at 500° C., slowly cooled in the furnace to 400° C., quenched in cold water, and given ageing treatments similar to those described above. Measurements were then made of the Brinell hardness, tensile properties, and electrical resistance of the specimens. Quenching from 400° C. and ageing at 140° C. gave a quicker and greater ageing effect than similar ageing after solution treatment at 500° C.; even after long ageing periods, solution treatment at 400° C. was superior to that at 500° C. Ageing for periods in excess of ~50 hr. at 140° C. gave reversion phenomena which are probably caused by coagulation of the precipitated phase. Solution treatment at 500° C. was only superior to that at 400° C. when the specimens were warm aged after a preliminary ageing for 30 days at room temp., and even then the difference in properties was slight. Better mechanical properties were obtained progressively as the manganese content of the alloys was increased from 0 to 1.25%. Electrical measurements showed that the specific resistance (a) fell continuously with warm ageing at 140° C. over periods of 0-1000 hr. after cold ageing for 0-30 days, (b) rose to a maximum after 1 hr. with warm ageing at 95° C., remained const. over ageing periods of 1-10 hr., and then fell continuously as ageing was continued to 1000 hr., and (c) rose steadily with cold ageing even after 1000 hr. Further experiments showed that the age-hardening properties were dependent on the method of warm ageing, i.e. the rate of rise in temp. of the specimen; specimens treated in oil baths, where the rate is high, gave Brinell hardness values of 75-107 kg./mm.², as compared with 112-128 kg./mm.² for specimens treated in air ovens where the rise in temp. varied from 15° to 2.5° C./min. The results are discussed and compared with those obtained by W. Feldmann (*Met. Abs.*, 1944, 11, 6), whose anomalous results are not confirmed.—E. N.

XIX.—WORKING

Low-Frequency Induction Heating of Extrusion Press. — (*Elect. Eng. and Merchandiser*, 1947, 24, (1), 25-26).—A description is given of a method of heating the container of an extrusion press by means of low-frequency induction. An Australian firm developed the process to maintain the container temp. of a press used for aluminium alloys at $450^{\circ} \pm 5^{\circ}$ C. Insulated copper rods were fixed axially in concentric circles in the container walls and connected in series with a single-phase transformer working at mains frequency. Curves are given of current consumption and heating rate.—D. M. L.

Electric Drive for Precious-Metal Rolling Mill. — (*Metallurgia*, 1948, 37, (220), 184).—A brief description of a "Brightside" mill for cold-rolling gold, silver, nickel, and copper.—M. A. V.

Sheet and Tinplate Mills—Roll-Dressing Formulæ. J. H. Mort (*Iron and Steel*, 1947, 20, (8), 351-356; (10), 431-435; (11), 481-482).—A comprehensive review of the principles involved, and the methods adopted for evaluating the contour of the rolls used in two- and three-high hot-rolling mills. M. stresses

the fact that the contour of the roll in the cold state (during regrinding) differs considerably from that under working conditions, and that due allowance must be made for this. Various formulæ are given relating concavity, roll temp., and roll dimensions.—D. W. C.

Roll Deflection. A. B. Cox (*Machine Design*, 1947, 19, (11), 147–150).—An Engineering Data Sheet in which formulæ are presented for the calculation of bending and shear deflection at points on a roll. A chart is given to simplify calculation of the max. deflection. The derivation of the equations used is given in an appendix.—D. M. L.

Molybdenum and Tungsten Wire Drawing. — (*Indust. Diamond Rev.*, 1947, [N.S.], 7, (84), 329–331).—A summary of B.I.O.S. Final Report No. 684.—R. W. R.

Production of Instrument Wires in Germany. — (*Indust. Diamond Rev.*, 1947, [N.S.], 7, (84), 334).—A summary of B.I.O.S. Final Report No. 1357. —R. W. R.

Reinforced Diamond Dies for Wire Drawing. — (*Indust. Diamond Rev.*, 1947, [N.S.], 7, (84), 324).—A discussion of a new British Standard (No. 1393 : 1947) for reinforced diamond dies.—R. W. R.

Production Processes : Their Influence on Design. XXVIII.—Rotary Impact Swaging. Roger W. Bolz (*Machine Design*, 1947, 19, (10), 101–106).—Cf. *Met. Abs.*, this vol. p. 206. An extended survey of the rotary impact swaging process. The principles of design of parts to be fabricated by this method and essentials in the materials to be used are discussed. Illustrations show a large number of the machines used, and drawings are given of typical swaged parts.—D. M. L.

Production Processes : Their Influence on Design. XXIX.—Roll Die Forging. Roger W. Bolz (*Machine Design*, (1947, 19, (11), 129–134).—Cf. preceding abstract. B. describes at length the process usually known as die rolling—a process of forming an article in one pass. It is largely used at present for the preforming of forging blanks. The differences in machine design from normal rolling mills are pointed out and the points to be borne in mind when designing parts for this production process described. Illustrations show typical roll dies and parts produced by the die rolling process.—D. M. L.

Production Processes : Their Influence on Design. XXX.—Wire and Ribbon Forming. Roger W. Bolz (*Machine Design*, 1947, 19, (12), 141–146).—Cf. preceding abstract. The basic principles of wire-forming machines are described and their use in the production of electrical components, small springs, clips, hooks, &c., discussed. Many of the machines used in the U.S.A. and typical products formed by them from wire and ribbon, are illustrated and described.—D. M. L.

Impact Extrusion in Germany. — (*Machinery (Lond.)*, 1947, 71, (1826), 460–464).—Extracted from B.I.O.S. Final Report No. 1405.—J. C. C.

†Relation of Machinability to Structure : Non-Ferrous Metallurgy. A. J. Murphy (*Proc. Inst. Mech. Eng.*, 1946, 155, (20), 236–238 ; discussion, 267–291 ; also (summaries) *Aircraft Prodn.*, 1946, 8, (93), 321–323 ; and *Engineering*, 1946, 161, (4196), 573–574).—M. discusses the relation of machinability to the crystal structure (space lattice), macrostructure, and microstructure of non-ferrous metals and alloys. Types of crystal structure encountered in the non-ferrous industrial metals are the face-centred cubic, body-centred cubic, and the hexagonal close-packed : the outstandingly good machinability of the hexagonal close-packed magnesium alloys is noted and it is suggested that this type of structure with its limited facility for cold working would be expected to cause easily removed, discontinuous chips to be formed during turning operations, but there is no evidence available from the study of the other hexagonal-latticed industrial metal—zinc—to support this theory. Size and nature of the macrostructure is also found to affect the

machinability of some metals and alloys. Hot working of duplex alloys with segregated constituents gives rise to directional macrostructures with directional mechanical properties; metals or alloys with such a banded or "fibrous" macrostructure are readily machined in transverse cutting operations, as in automatic turning. Three main types of microstructure are discussed: (1) homogeneous alloys with a one-phase microstructure, (2) alloys with a complex microstructure, and (3) alloys, either homogeneous or complex, containing special elements added to improve machinability. It is difficult to determine the relative merits of groups (1) and (2) in respect of machinability. Addition of lead to brass greatly improves machinability, only slightly lowering the tensile strength; one or two explanations of this fact are given and briefly discussed. Addition of 1% tellurium to pure copper increased the machinability by 500% in a drilling test. Free-cutting wrought aluminium alloys are also mentioned, and the conclusion is reached that a metallographic study of the mode of deformation in the vicinity of the particles in free-cutting non-ferrous alloys would greatly assist towards the solution of the significance of structural factors, and that this study should include an examination of the shearing process occurring at the elevated temp. attained at the tool face.—W. A. M. P.

Direction of Maximum Crystal Elongation During Metal Cutting. G. H. Townend (*J. Appl. Physics*, 1947, **18**, (5), 489–490).—A letter from which an essential diagram was omitted, and which was later reprinted complete. See following abstract.—G. V. R.

Direction of Maximum Crystal Elongation During Metal Cutting. G. H. Townend (*J. Appl. Physics*, 1947, **18**, (8), 784).—A letter pointing out an error in a paper by Merchant on the mechanics of the metal-cutting process (*J. Appl. Physics*, 1945, **16**, 267, 318; *Met. Abs.*, 1945, **12**, 303, 340). An equation connecting the shear angle, rake angle, and the direction of max. crystal elongation (equation (1), p. 269, of M.'s paper) is corrected, and the derivation of the new expression is given.—G. V. R.

Machining Cast Aluminium Alloys. J. J. Stobie, Jr. (*Modern Metals*, 1947, **3**, (10), 16–23).—A comprehensive review, covering tooling, cutting compounds, lathe practice, cutting speeds, shaping, drilling, reaming, tapping, threading, sawing, and filing. A selected *bibliography* of 48 references is appended.—N. B. V.

***Band-Sawing Aluminium—With and Without Lubricants.** H. J. Chamberland (*Modern Metals*, 1947, **3**, (11), 25–26).—A brief note demonstrating the reduction in cutting cost effected by the use of a suitable lubricant. The tests were carried out on 17S-T extruded bar of Brinell hardness 100.—N. B. V.

Drilling, Tapping, Threading, Turning, Sawing, and Rectification [Grinding] of Magnesium Alloys [—II]. — (*Rev. Aluminium*, 1947, (135), 237–242).—Cf. *Met. Abs.*, 1947, **14**, 228. This account is based on data from the Société Générale du Magnésium, from the Dow Chemical Company's, 1944 data book, and from the O.T.A.L.U.; it contains no novel material.—F. A. F.

Composition, Control, and Selection of Coolants for Working Metals.—I.—II. E. L. H. Bastian (*Steel*, 1947, **120**, (20), 82–83, 117, 120, 124; (21), 94–95, 107–108, 112).—(I.—) The characteristics of soluble oils and pasty compounds, and the treatment of added water, are described, and the importance of cooling and concentration control explained. (II.—) The requirements and method of use of coolants for (1) cutting and sawing, (2) grinding, (3) rolling, and (4) drawing, stamping, and forming, are outlined.—M. A. V.

The Mechanism of Cutting-Fluid Action. Milton C. Shaw (*J. Appl. Physics*, 1947, **18**, (7), 683).—With reference to a note on the action of cutting oils by Brewington (*J. Appl. Physics*, 1947, **18**, 260; *Met. Abs.*, 1947, **14**, 408), it is pointed out that both physical and chemical aspects must be considered. The physical properties of a useful fluid must ensure a sufficient mobility for a

satisfactory quantity of fluid to reach the cutting point. At this stage, it is necessary that the chemical nature of the fluid should enable it to react with the metal cut to form a low-shear-strength solid lubricant. The mobility factor is of negligible significance at low cutting speeds, so that high cutting speeds are necessary for establishing relationships between the physical properties and efficiencies of cutting fluids. In general, the chemical aspect is the more important, as evidenced by the effectiveness of good cutting fluids when applied to the tool in the vapour form, and by the use of metal-cutting processes in the manufacture of certain chemical products ("mechanical activation").—G. V. R.

Shot-Peening Aluminium Forgings. — (*Machinery (Lond.)*, 1947, 71, (1833), 651-656).—Annealed malleable iron shot is used for shot-peening aluminium alloy crankcase sections and forged pistons to increase fatigue endurance. The equipment is described and illustrated. An airless machine, containing vertical wheels rotating at 1800 r.p.m. to throw shot against the work, is employed; and the intensity of peening is measured in terms of the curve developed by a sample steel strip which is peened on one side only.

—J. C. C.

XX.—CLEANING AND FINISHING

Factors to be Considered in Cleaning of Aluminium. Allen G. Gray (*Products Finishing*, 1947, 11, (8), 58-62).—A general account.—G. T. C.

Highlighted Finish May Add to Attractiveness of Aluminium Articles. Allen G. Gray (*Products Finishing*, 1947, 11, (11), 70-71).—G. describes a method of finishing the raised portions of a surface with one type of finish and the recessed portions with another. The raised portions are stopped-off and the background sand-blasted and given a caustic treatment. The background is then stopped-off while the raised portions are buffed. The whole article is then anodized.—G. T. C.

Reflector Finishing Process [for Aluminium]. Ralph Pettit (*Steel*, 1947, 120, (25), 114, 117).—The "Alzak" finishing process has been developed for producing a durable mirror finish on aluminium. This consists of a preliminary buffing for bright reflectors, or chemical etching for diffuse reflection, followed by electrolytic polishing in fluoboric acid, and finally anodizing in another electrolyte to give a thin, hard, transparent coating.—M. A. V.

Aluminium Surface Preparation for Organic Finishing. Allen G. Gray (*Products Finishing*, 1947, 12, (1), 92-96).—A general discussion of the methods available.—G. T. C.

Electrolytic Polishing of Aluminium Alloys; the "Polectro" Process. Lucien Richard (*Rev. Aluminium*, 1947, (135), 234-235).—An account of a patented French process: the composition of the bath is not given. It is stated that this process is valuable in that it is applicable to a wide range of alloy compositions.—F. A. F.

Frosted Finish for Aluminium. Allen G. Gray (*Products Finishing*, 1947, 11, (9), 100, 102, 104).—A brief description of the use of caustic soda solutions to give a frosted finish on aluminium.—G. T. C.

Electrolytic Polishing and Lapping for Mirror Finishes [on Copper and Brass]. Joseph Mazia (*Steel*, 1947, 120, (20), 84-87, 126).—The technique of electrolytic polishing, for commercial and metallographic purposes, is described generally, with working details for cold-drawn copper, brass (70:30 and 60:40), and steels.—M. A. V.

Finishing Magnesium Alloys. Allen G. Gray (*Steel*, 1947, 120, (23), 82-83, 86, 117, 118, 120, 122).—Magnesium alloys may be cleaned mechanically or chemically (by solvents, alkaline cleaners, or chromic or sulphuric acid).

pickling baths). The methods and applications are described, and brief details are given of the anodizing of magnesium.—M. A. V.

Organic Finishes for Magnesium Alloys. Allen G. Gray (*Steel*, 1947, 120, (26), 72-74, 101).—Cf. preceding abstract. Combinations of alkyd and phenolic resins are recommended as primers; and oil-base phenolic resin varnishes or enamels pigmented with aluminium paste are satisfactory for baked finishes. Chemical finishing of magnesium alloys is also briefly described.—M. A. V.

***Electrolytic Polishing of Magnesium** [—I, —II]. George Black (*Metal Finishing*, 1947, 45, (6), 86-87, 94; (7) 84-86).—(I.—) A review of the information contained in British Patents 550,175 and 550,176, which describe various methods of polishing magnesium and its alloys electrolytically. (II.—) B. describes results obtained with a solution recommended by Jacquet, consisting of 375 ml. of orthophosphoric acid, density 1.71, and 625 ml. of 95% by vol. ethyl alcohol. 18-8 stainless steel or nickel sheet is used as a cathode. This method gave satisfactory results. A second solution used was a cold one of 70% acetic acid and 30% perchloric acid (60% solution). A c.d. of 1.5 amp./cm.² was employed. This solution has the disadvantage of being explosive under certain conditions. Trials were also carried out on the type of solution mentioned in British Patent 550,176, and the conclusion was reached that the optimum bath composition is 10% hydrochloric acid in ethylene glycol mono-ethyl ether. This should be used at 10° C. or less, with a voltage of 10-15 V.—G. T. C.

Metal Polishes. J. M. Vallance (*Manuf. Chemist*, 1947, 18, (2), 75-80).—Special polishes have been developed for aluminium, chromium, nickel, &c., but for most household purposes 2 well defined types are satisfactory: (a) the ordinary type for brass, copper, &c., (b) a less drastic one for silver. pH, the necessity for investigations into the relative hardness of the metal and abrasives by abrasion tests, water as an additional solvent to hydrocarbons, and the use of glycols for facilitating soap dissolution in hydrocarbons are discussed. The requirements of a universal metal ("brass") polish with reference to cleaning, polishing, and the retardation of further tarnishing are critically examined from the point of view of available abrasives, detergents, emulsifying agents, and solvents. The formulæ and manufacturing procedure for 3 general-type polishing pastes and 4 liquid polishes are given. Brief reference is made to polishing powders and some of the more important patents.—H. A. H.

Polishes for Silver and Chromium Plate and Cleansers for Aluminium. J. M. Vallance (*Manuf. Chemist*, 1947, 18, (3), 124-128).—Silver polishes usually contain the mildest abrasives in association with soaps, traces of alkalis, and water. Suitable materials and patents relating to silver polishes are discussed and the formulæ of 2 paste and 3 liquid silver polishes given; the latter have an ammoniacal aqueous base. Chromium requires more cleaning than polishing, and after enumerating typical components the formulæ of 3 chromium-plate polishes are listed. The use of such polishes containing free oil or fatty acids is suggested for nickel and pewter. Aluminium cleansers are usually based on neutral soaps, synthetic fatty alcohol wetting agents, sodium silicate, and mild abrasives. 3 typical compositions are quoted. General specifications and patents covering polishing cloths, pads, and impregnated wadding are reviewed.—H. A. H.

Fishtails—An Old Buffing Problem. T. R. Treadwell (*Metal Finishing*, 1947, 45, (9), 68-70).—Methods are considered for reducing drag marks which appear during buffing and which originate at pores in the metal which have not been sufficiently removed during previous operations. Among suggestions made are: the use of lighter pressures, the employment of a softer buff, and, in some cases, the adoption of a faster cutting composition.—G. T. C.

Modern Mechanical Surface Finishing. [—I, —II]. Martin Manler (*Metal Finishing*, 1947, **45**, (11), 62–66; (12), 82–88).—(I.—) M. surveys the various types of polishing wheel and the applications of each. Polishing-wheel abrasives and their selection and classification are reviewed. Mention is made of the types of glue suitable for use on polishing wheels. (II.—) A detailed review of various factors affecting the efficiency of wheels, buffs, and belts. Data are listed for the coating and drying of polishing wheels and recommendations made for the polishing method to be used on aluminium, brass, stainless steel, zinc, nickel, Monel metal, and sheet steel. Belt finishing is discussed and methods of treating the belt described. Buffing is dealt with in detail and information given on wheel speeds for various metals and types of buffing composition suitable for different applications. Burring is briefly mentioned.—G. T. C.

Tricks of the Polishing Trade. H. Moore (*Metal Finishing*, 1947; **45**, (11), 78–79).—M. gives a number of practical hints on polishing and buffing holders for parts that are otherwise difficult to handle.—G. T. C.

Barrel Polishing of Small Brass Parts. T. S. Blair (*Iron Age*, 1947, **160**, (23), 77).—The method of polishing small brass paper-fasteners by barrel polishing in dry maple sawdust was adopted as a result of an investigation of a number of methods. Maple sawdust has the advantage of having small hard fibres—absent in softer woods—which act as a mild abrasive and give a finish that, it is claimed, will last for two years under normal exposure conditions.—J. H. W.

Silver Can be Electropolished. Allen G. Gray (*Products Finishing*, 1947, **11**, (11), 70).—A brief note giving the composition and operating details of an electrolytic-polishing method for silver.—G. T. C.

Proper Control of Pickling Operations Important in Many Finishing Operations. Allen G. Gray (*Products Finishing*, 1947, **11**, (12), 74, 76, 78).—A brief description of the importance of adequate control of pickling baths. Simple chemical-analysis methods are given.—G. T. C.

The Cleaning of Metals. III.—Further Operations. R. Groves (*Metallurgia*, 1948, **37**, (219), 147–149).—Cf. *Met. Abs.*, this vol., p. 304. The two-stage cleaning of buffed or polished metals prior to electroplating is discussed. An emulsifiable cleaner or degreasing solvent is first used, followed by alkaline cleaning. The advantages of perchlorethylene and tetrachlorethylene as solvent degreasers are explained, and the uses of petroleum distillates considered.—M. A. V.

The Cleaning of Metals. IV.—Emulsifiable Cleaners. R. Groves (*Metallurgia*, 1948, **37**, (220), 217–219; discussion, 216, 219).—Cf. preceding abstract. The particular applications of emulsifiable cleaners, their method of use, and limitations are described. The choice of type of washing machine is discussed.—M. A. V.

Metal Cleaning—Methods and Results. Jas. Rowan Ewing (*Metal Finishing*, 1947, **45**, (10), 82–84).—The multi-phase type of cleaning system is described in which a two-layer bath is used, the top layer being an organic solvent and the bottom layer an emulsified organic solvent in water. The two phases may also be used as a spray washing process. Details of the solvents used are not mentioned. Photographs illustrate the effectiveness of the method compared with other cleaning methods.—G. T. C.

Testing of Alkaline Metal Cleaners. A. Mankovich (*Metal Finishing*, 1947, **45**, (12), 77–78, 88).—Various methods of evaluating alkaline cleaners are described under the following headings: (1) water break, (2) Nielsen, (3) spray pattern, (4) fluorescent, (5) weight of residual soil, (6) wiping, (7) proposed "residue-pattern" method evolved by M. The limitations and advantages of each method are discussed.—G. T. C.

Barrel Finishing of Metal Products. IX.—The Relation of Barrel Finishing and Polishing in General Production. H. Leroy Beaver (*Products Finishing*, 1947, 11, (8), 46–48, 50, 52, 54, 56).—Cf. *Met. Abs.*, this vol., p. 65. A general discussion on barrel finishing *versus* polishing and buffing.—G. T. C.

Barrel Finishing of Metal Products. X.—Factors in the Evaluation of Steel Burnishing Materials. H. Leroy Beaver (*Products Finishing*, 1947, 11, (9), 74–76, 78, 82, 84).—Cf. preceding abstract. B. briefly discusses the influence of size and shape of burnishing materials on their effectiveness in the barrel.—G. T. C.

Barrel Finishing of Metal Products. XI.—Barrel Finishing as an Intermediate Operation. H. Leroy Beaver (*Products Finishing*, 1947, 11, (10), 74, 76, 78, 80, 82, 84, 86).—Cf. preceding abstract. An account of the use of barrel methods to replace coarse-polishing operations.—G. T. C.

Barrel Finishing of Metal Products. XII.—Factors in the Barrel Finishing of Light-Specific-Gravity Parts. H. Leroy Beaver (*Products Finishing*, 1947, 11, (11), 28–30, 32, 34, 36, 38).—Cf. preceding abstract. The barrel finishing of light alloys is considered.—G. T. C.

Barrel Finishing of Metal Products. XIII.—Barrel-Finishing Procedure and Its Relation to Porosity of Electrodeposited Surfaces. H. Leroy Beaver (*Products Finishing*, 1947, 11, (12), 38, 40, 42, 44, 46, 48, 50).—Cf. preceding abstract. B. explains the relationship between barrel finishing and the porosity of the subsequent electrodeposit.—G. T. C.

Barrel Finishing of Metal Products. XIV.—The Phenomenon Termed "Ball Pattern". H. Leroy Beaver (*Products Finishing*, 1947, 12, (1), 36, 38, 40, 42, 44, 46, 48, 50).—Cf. preceding abstract. The possibility of parts becoming damaged during barrel finishing is considered. Damage is unlikely to occur if (1) proper care is taken during loading and unloading operations, and (2) the barrel is run at the correct speed.—G. T. C.

Barrel Finishing of Metal Products. XV.—A Discussion Concerning Barrel Loads and Barrel Speeds. H. Leroy Beaver (*Products Finishing*, 1947, 12, (2), 76, 78, 80, 82, 84, 86, 88).—Cf. preceding abstract. A general survey.—G. T. C.

Pre-Treatment for Barrel Plating. Mario Mazzone and Floyd McKnight (*Metal Finishing*, 1947, 45, (11), 75–77, 82).—The authors consider wet and dry tumbling processes in both tilting and horizontal barrels. The size and weight of barrel abrasive and metallic slugs are given for ferrous and non-ferrous work.—G. T. C.

Finishing Chrysler and DeSoto Passenger-Car Bodies. Bryant W. Pocock (*Products Finishing*, 1947, 11, (10), 24–26, 28, 30, 32, 34, 36, 38, 40).—Devoted mainly to organic coatings, but mention is made of electrodeposition and details are given of a bath for immersion-coating aluminium alloy pistons with brass. The bath composition is: copper cyanide 2, free sodium cyanide 1.25, sodium zincate 32, sodium hydroxide 16 oz./gal., and lead carbonate 1.5 lb./1200 gal. The temp. of operation is 120°–125° F. (49°–52° C.).—G. T. C.

The Basic Principles of Grinding Hard Materials. Ph. Kruel (*Indust. Diamond Rev.*, 1947, [N.S.], 7, (84), 325–328; (85), 367–371).—R. W. R.

XXI.—JOINING

Copper Furnace Brazing: Equipment and Methods Now Being Applied in Large-Scale Industrial Operations. — (*Machinery (Lond.)*, 1947, 71, (1834), 383–688).—Experience gained at plants of the N. American Aviation, Inc., is discussed. Furnaces, joint design, the use of jigs, and methods of preventing decarburization are considered. The copper flows better on slightly roughened than on polished surfaces, and is best applied as tightly fitting wire rings, care being taken that no air pockets are entrapped. Carborundum is recommended for temporary supports.—J. C. C.

Electric-Furnace Brazing for Mass Production. Henry Eickelberg (*Iron Age*, 1947, 160, (25), 56-59).—E. describes the use of a continuous, controlled-atmosphere, electric furnace for copper brazing, silver soldering, and bright annealing of a variety of products. The process gives flexibility of size and shape, close temp. control, economy of operation, and improved quality of product.—J. H. W.

"Package" Welds Stainless Steel and Aluminium Shops. — (*Steel*, 1947, 120, (22), 116).—A description of the manufacture of prefabricated shops by welding aluminium or steel sheet on to a frame.—M. A. V.

New Flux-Cored Filler Rods for Torch Welding. F. Danhier (*Weld. J. (J. Amer. Weld. Soc.)*, 1947, 26, (4), 252-253s).—The rod is formed cold from a thin rolled band of the selected composition which is folded upon itself several times so that when finished it is outwardly round with folds projecting internally. Fluxing agents and some metallic additions are made by filling the rod with powder. Other metallic additions may be made in the form of thin ribbon. In this manner filler metal may be deposited of a composition which could not be worked as wire. Since flux is fed to the puddle automatically and without interruption, the resulting welds are unusually uniform in appearance.—P. H.

Aluminium Strips Butt Welded for Cyclotron Magnet Coil. J. A. Oehler (*Iron Age*, 1947, 160, (23), 80-83).—O. describes how some 1700 fifty-foot lengths of aluminium strip, $\frac{5}{16} \times 4$ in., were butt welded on a standard flash welder, the strip being continuously fed from the welder to the winding screw.—J. H. W.

Metallic Joining of Light Alloys [—VI, —VII, —VIII]. — (*Light Metals*, 1947, 10, (113), 273-275; (114), 365-368; (115), 421-424).—Cf. *Met. Abs.*, this vol. p. 209. (VI.—) The advantages of flux-less welding are again described, and its application by flame welding to copper is touched on. Electrical fusion welding without flux is a more controllable and satisfactory process. (VII.—) Flame welding applied to aluminium alloys is described, and various flux compositions are quoted and discussed. The lower flame temp. of propane as compared with acetylene causes the former gas to be favoured. (VIII.—) An account is given of the technique of gas-welding aluminium alloys, including brief reference to the welding of aluminium alloy castings. The need for the thorough removal of residual welding flux is emphasized.—F. A. F.

Welding in the U.S. Aircraft Industry [—II]. R. Grimaud (*Aircraft Eng.*, 1947, 19, (225), 361-365).—Cf. *Met. Abs.*, this vol., p. 210. G. discusses in a general way electrodes and inspection methods. Several extracts from American reports are quoted (N.A.C.A. O.C.R. No. 44,423—March 1944; N.A.C.A. O.C.R. 4316, N.A.C.A. O.C.R. 5C26, and one un-numbered report) and flash-butt welding, arc welding, union-melt welding, Heliarc or Argonarc welding, and atomic-hydrogen welding are very briefly mentioned.—W. A. M. P.

Adams Lecture for 1946—New Frontiers in Welding. Wendell F. Hess (*Weld. J. (J. Amer. Weld. Soc.)*, 1947, 26, (2), 114-120).—P. H.

***Progress Report on the Flash Welding of High-Strength [24S-T and 14S-T] Aluminium Alloys.** R. Della-Vedova and E. A. Reynolds (*Weld. J. (J. Amer. Weld. Soc.)*, 1947, 26, (2), 81-87s).—The report concerns an investigation into the flash welding of 24S-T aluminium alloy rod and tube on a 100-kVA hydraulically operated flash-welding machine equipped with ignitron contactors. Some tests were also made on joints of 24S-T rod to 14S-T aluminium alloy rod. Methods of end preparation and cleaning and welding variables were investigated, and tensile and corrosion tests were carried out. In the case of rod the most satisfactory results were obtained by a pressure-resistance technique, but for tubing the normal flash-welding procedure proved to be best. The most critical welding variable was the timing of

the cut-off of current, but the flashing time and amount of upset are also important. Square-cut ends were found to give the best results for both tube and rod, bevelled ends giving low and erratic results. The authors conclude that flash welding of the alloy 24S-T on 100-kVA. equipment normally used for steel is a practical proposition between the limits: (1) $t \geq 0.065$ in., (2) $D/t \leq 16$, and (3) $A < 0.45$ in.² or < 0.08 in.², where t is the wall thickness of the tubing and D the diameter, and A the cross-sectional area of the tube or rod. Under these conditions joint efficiencies of 80–90% may be expected with rod and over 90% with tube. After a 250-hr. salt-spray-corrosion test, flash-welded specimens showed severe attack at the weld line. Specimens anodized in chromic acid, however, showed only minor breakdown of the coating, while those specimens anodized in sulphuric acid and sealed with potassium dichromate showed no attack whatever.—P. H.

Spot Welding of [Aluminium] Primary Structures. — (*Steel*, 1947, 120, 20), 88, 128).—A brief account of spot-welding aluminium alloy structures for aircraft.—M. A. V.

***Fatigue Tests on Some Spot-Welded Joints in [24S-T] Aluminium Alloy Sheet Materials.** H. J. Grover and L. R. Jackson (*Weld. J. (J. Amer. Weld. Soc.)*, 1947, 26, (4), 215–232s).—Three simple structural components were examined—spot-welded stiffened panels, sheets with spot-welded attachments, and spot-welded lap joints. These were prepared from Alclad 24S-T aluminium alloy material in various gauges from 0.025 to 0.051 in. thick. Results indicate that the fatigue strength of the stiffened panels was more closely related to the static buckling stress than to the static crippling stress. Spot-welded attachments reduced the fatigue strength of test-pieces to approx. the same degree as these attachments reduced the static tensile strength. In many instances an increase in the static shear strength of lap joints resulted in an increase in the fatigue strength, although not usually a proportionate increase.—P. H.

***Summary of Results of Tests Made by Aluminium Research Laboratories of Spot-Welded Joints and Structural Elements.** E. C. Hartmann and G. W. Stickley (*Weld. J. (J. Amer. Weld. Soc.)*, 1947, 26, (4), 233–251s; and *Tech. Notes Nat. Advis. Cttee. Aeronautics*, No. 869).—The results indicate that the performance of spot-welded and riveted members under static loading are comparable. Spot-welded members are slightly inferior under impact loads and definitely inferior under repeated loading, than members fabricated by riveting. Results are quoted of tests on members made from various alloys on both A.C. and stored-energy spot-welding machines, as well as by riveting.—P. H.

***The Classification and Recording of Spot-Weld Defects Revealed by Radiography.** (McMaster, Lindvall, and Dial). See p. 359.

***Optimum Welding Conditions and General Characteristics of Spot Welds in Magnesium Alloy Sheet.** W. F. Hess, T. B. Cameron, D. J. Ashcraft, and F. V. Winsor (*Weld. J. (J. Amer. Weld. Soc.)*, 1947, 26, (5), 268–282s).—The authors examined the production of spot welds in three magnesium alloys of nominal composition manganese 1.5, aluminium 3.0, zinc 1%; and aluminium 6, zinc 1%, of various thicknesses. In general the spot-welding technique is similar to that used for aluminium alloys. Chemical pre-cleaning is recommended (cf. *ibid.*, 1947, 26, (3), 170–190s; *Met. Abs.*, this vol., p. 120). Chemical preparation gives greater resistance to electrode fouling, a serious problem with magnesium alloys, than mechanical preparation. A forging pressure is not necessary and spot welds in magnesium alloy sheet are not susceptible to cracking when they are otherwise sound. Data are presented showing the effect of welding variables on the strength-current characteristics.—P. H.

XXII.—INDUSTRIAL USES AND APPLICATIONS

Aluminium and Its Applications. Hiram Brown (*Light Metal Age*, 1947, 5, (12), 13–20).—A reprint of Chapter 2 of a forthcoming publication "Aluminium and its Applications" (Pitman Publishing Corporation, N.Y., U.S.A.).
—M. A. V.

Aluminium and Its Alloys. — (*Metallurgia*, 1948, 37, (220), 185–186, 194).—Present-day applications are surveyed.—M. A. V.

Aluminium in Agriculture. — (*Indust. Australian*, 1947, 102, (2600), 1052–1053).—A brief enumeration of the applications of aluminium in the agricultural industry. The metal, because of its low density and favourable corrosion characteristics, is being increasingly used for spraying apparatus, and for portable irrigation machinery. Orchard ladders and small hand tools may also be made from aluminium, and it is now being applied to structural work (barns and houses) and for transmission of electrical power.—G. V. R.

Weight-Reduction of Bicycles Should Not Be Limited Only to Revolving Parts [Use of Aluminium Alloys]. Maurice Arbault (*Rev. Aluminium*, 1947, (134), 218).—A discussion of the possibilities of weight savings in different parts of bicycles by the use of aluminium alloys.—F. A. F.

Aluminium Trolley Coaches. — (*Modern Metals*, 1947, 3, (10), 14–15).—A brief description, with illustrations, of a 44-seater vehicle incorporating considerable quantities of aluminium. Extrusions are, in general, of 53S or 61S alloy, and sheet of 52S.—N. B. V.

[Aluminium and Its Alloys in] Structural Engineering and Building. — (*Aluminium Courier*, 1947, (1), 7 pp.).—Includes details of a prefabricated, bungalow-type aluminium alloy house and illustrates other examples of the use of aluminium in building and construction.—S. G.

Aluminium Industry in Hungary. A. Domony and E. Köves (*Light Metals*, 1947, 10, (114), 353–364).—A review of the status of the aluminium industry in Hungary. Present output totals 16,000 tons per year. Many applications are discussed, with special emphasis on impact extrusion.
—F. A. F.

The Sterilization of Operating Theatres [Use of Aluminium Sheet]. Meynis de Paulin (*Rev. Aluminium*, 1947, (134), 200–204).—A consideration of the requirements for sterilization of a complete operating theatre, followed by a description of how they are attained in a clinic at Saint-Ouen. The interior walls must be of uniform temp., resistant, durable, and of compact texture, and anodized dyed aluminium sheet was used.—F. A. F.

Self-Priming Aluminium Centrifugal Pumps. — (*Modern Metals*, 1947, 3, (11), 24–25).—N. B. V.

Die-Cast Aluminium Sink: Record of a Year's Use. — (*Light Metals*, 1947, 10, (115), 379–380).—The sink was installed by normal methods and was in contact with other usual fittings. It was in very satisfactory condition after its year's service.—F. A. F.

Light Alloys in the Internal-Combustion Engine [—I, —II, —III]. C. R. Draper (*Light Metals*, 1947, 10, (113), 265–270; (114), 369–375; (115), 425–430).—(I.—) An account is begun of practical experience with aluminium and magnesium alloys in this field. The advantage in reducing reciprocating weight may be large even when slower-speed engines, such as marine Diesels are concerned. The history of the development of light-weight Diesels is then touched upon and lists of light-alloy components given; performance data for aircraft Diesels are also given, together with those for petrol-fueled radial engines. While petrol-driven aircraft engines weigh about 1 lb./b.h.p., the motor-car engine often weighs as much as 10 lb./b.h.p. (II.—) Lists of components are given for Rolls-Royce and other automobile engines and for

motor-cycle engines. Aluminium alloy pistons and piston designs are discussed at length from the point of view of cooling and wear problems and surface treatments. (III.—) The value of aluminium alloys for cylinder heads depends mainly on their high thermal conductivity; their use is not confined to high-performance engines, and their influence in various car and motor-cycle engines is discussed. Light alloy cylinders, cylinder blocks, and crankcases are then considered in car, motor-cycle, and aeroplane engines, and individual performances quoted; the use of magnesium alloys is touched on and some design hints are given.—F. A. F.

Light-Alloy Piston Materials. A. Schofield and L. M. Wyatt (*Metallurgia*, 1948, 37, (220), 187–194).—The types of cast and forged light alloys used for pistons in U.K., Germany, and U.S.A. are classified and listed, and the effects of the separate alloying elements on aluminium described. The methods of fabrication, service conditions, and mechanical and physical properties of the alloys are summarized.—M. A. V.

Heavy-Duty Light-Alloy Engines. — (*Modern Metals*, 1947, 3, (11), 22–23).—Describes heavy-duty gasoline engines in which aluminium alloy die-castings are extensively used.—N. B. V.

The Evolution of the High-Powered [Aircraft Engine]. Léonce Keuleyan and Maurice Victor (*Rev. Aluminium*, 1947, (135), 243–252).—Of engineering interest; there are few references to materials.—F. A. F.

[Light Alloys] In the Service of Science [—I]. — (*Light Metals*, 1947, 10, (115), 408–417).—A survey of the uses of aluminium and magnesium in scientific and technical apparatus. Applications in which low inertia is favourable are general, centrifuges being a good example. Corrosion-resistance of the aluminium alloys often leads to their selection for applications in which chemical stability is important; scale pans and parts for stills are examples. The special surface characteristics and effects obtainable with aluminium alloys lead also to their use in optical instruments, including structural parts as well as reflectors.—F. A. F.

All-Metal Finishes for Commercial Plants [Renolite]. Stephen Porter Lathrop (*Light Metal Age*, 1947, 5, (12), 21).—A brief description of a shop finished in "Renolite" (plywood sandwiched between aluminium sheets, with an outer veneer of mahogany). This is easily cleaned and has good thermal insulating properties.—M. A. V.

Composite Materials Attract Designers of Lighter Structures. — (*Steel*, 1947, 120, (23), 76–79, 101).—Laminated sheets of steel clad with aluminium, Monel metal, stainless steels, or other materials, and compound wood-metal sheets are being used increasingly for structural purposes, e.g. architecture, rolling stock, and furniture. Fabricating technique is described and present uses summarized.—M. A. V.

Lead, Lead Alloys, and Lead [Oxide] Powders for Accumulators. C. Drotschmann (*Arch. Metallkunde*, 1947, 1, (4), 159–168).—The specifications for the impurities in, the physical and chemical properties, and the methods of analysis of lead, antimony, and alloys of lead with 8–9% antimony are reviewed, together with a description of the methods of production and production control of lead oxide powders.—E. N.

Lead Oxides for the Accumulator Industry. C. Drotschmann (*Arch. Metallkunde*, 1947, 1, (4), 169–175).—Cf. preceding abstract. D. reviews the preparation, properties, and methods of analysis of the oxides of lead.—E. N.

Plates for Lead Accumulators. C. Drotschmann (*Arch. Metallkunde*, 1947, 1, (4), 175–187).—Cf. preceding abstract. D. reviews the methods of production, and the physical and chemical methods of controlling the quality of positive and negative plates.—E. N.

Magnesium Bows and Landing Nets. P. V. Leivo (*Modern Metals*, 1947, 3, (11), 19).—N. B. V.

All-Magnesium 2-Seater Aircraft ["Sprite"]. — (*Light Metals*, 1947, 10, (114), 338-339).—A brief account of the "Sprite", a new all-magnesium aeroplane to be built by Essex Aero, of Gravesend. Data on the characteristics of versions with fixed or with retractable undercarriage are provided.—F. A. F.

The Platinum Metals in 1947. — (*Metallurgia*, 1948, 37, (219), 140).—Import and export statistics are given for 1947, and some present applications described.—M. A. V.

Drawing and Forming Steel with Zinc Alloy Dies. —I, —II, —III, —IV. S. Menton (*Steel*, 1947, 120, (20), 92-93, 100, 103, 104, 107; (22), 104-105, 129-130, 132, 134, 136, 138-140; (23), 80-81, 109, 112, 114, 117; (24) 94-96, 122, 124, 127, 128, 130).—(I.—) The use of Kirksite-type alloys as dies for stamping steel is illustrated, and the technical and economic advantages discussed. (II.—) Die design and pattern-making are reviewed. (III.—) The technique of melting and casting Kirksite is surveyed. (IV.—) M. describes the finishing operations (machining and chrome-plating and metalizing), the "recasting" of worn dies, and some of the applications.—M. A. V.

Recent Developments in Metals and Their Processing. W. F. Craig, Jr. R. A. Lubker, and W. E. Makin (*Machine Design*, 1947, 19, (10), 71-78).—A survey of new metals and metal-processing methods. The authors discuss the production of steels to hardenability limits and the use of small quantities of boron to increase the hardenability. Special developments have made possible the production of very fine steel wires, usually 18-8 type stainless steels with coercivity values of 200-300 oersteds and retentivity limits of 2000-3000 gauss, for use in magnetic recording apparatus. Work on new uses for light alloys and particularly secondary metal is surveyed. A mention is made of cobalt-base alloys (Co-Cr-Mo) developed in the form of precision castings for service at 950° C. The various casting methods are reviewed and technique of counter-gravity casting is described. The section on welding and joining methods outlines some of the more notable advances of recent years. Some new fabrication processes for powder metals are discussed.

—D. M. L.

XXIII.—MISCELLANEOUS

Aluminium and Silicosis. W. E. George (*Min. Mag.*, 1947, 76, (1), 60-61).—Some of G.'s conclusions on the prevention of silicosis by aluminium treatment are given.—P. L.

Injury to Apricot Leaves from Fluorine Deposit [from Aluminium Reduction Factories]. E. R. de Ong (*Phytopathology*, 1946, 36, 469-471; *C. Abs.*, 1946, 40, 5804).—Mature apricot leaves in orchards near aluminium reduction plants are damaged by released fluorine if the flue gases are not carefully controlled.

Safeguards Against Fluorine Hazards. — (*Manuf. Chemist*, 1947, 18, (1), 16).—A brief survey. Reference is made to fluorosis in sheep grazing on pastures contaminated by fumes from an aluminium plant 1½ miles away.—H. A. H.

Copper and Copper Alloys: A Survey of Technical Information During 1947 [—II]. E. Voce (*Metallurgia*, 1948, 37, (219), 141-145).—Cf. *Met. Abs.* this vol., p. 311. Research and developments reviewed include corrosion by town gas, attack of superheated water on phosphor bronze, stress-corrosion of high-tensile brasses in sea water, powder metallurgy, welding and brazing, electroplating and electrolytic polishing, internal stresses, scaling, and the metallography of aluminium bronze. A bibliography of 115 references to the literature surveyed is appended.—M. A. V.

Magnesium and Its Alloys: A Review of Technical Progress During 1947.

[—II]. R. G. Wilkinson (*Metallurgia*, 1948, **37**, (219), 133–136).—Cf. *Met. Abs.*, this vol., p. 312. Progress reviewed includes the forging of aluminium bearing alloys (Elektron AZM and AZ855), the use of a non-corrosive fluoride-base welding flux, cold forming, and the improvement of corrosion-resistance. Various reports of researches into structure and properties, and some new applications, are also noted. A bibliography of 73 references to the literature is appended.—M. A. V.

Metallurgical Advances [in 1946]. A. G. Arend (*Chem. Age*, 1947, **56**, (1437), 77–80).—A review of developments during 1946, including aluminothermic methods in casting, the use of magnesium for cathodic protection of pipe-lines, thorium-bearing alloys for electrical resistors, lithium and beryllium in aluminium alloy sheets, and heat-resisting alloys.—M. A. V.

A View of the Future of Metals. Ernest E. Thum (*Metal Progress*, 1946, **50**, (5), 844–846).

War-Time Developments in Metals and Alloys. — (*Nature*, 1947, **160**, (4061), 308–309).—Cf. *Met. Abs.*, this vol., p. 132. A brief report of a lecture by Sir Edward Appleton to the Institute of British Foundrymen. Particular stress is laid on magnetic materials.—G. V. R.

Metallurgists To Utilize Nucleonic Methods. — (*Chem. Eng. News*, 1947, **25**, (45), 3292).—A very brief summary of 8 papers given at the National Metal Congress, Chicago, October 1947.—H. A. H.

Preliminaries to the Statistical Study of Materials for Aircraft Construction. Stanislas Schneider (*Publ. Sci. Tech. Ministère Air (France), Notes Techniques No. 24*, 1947, 49 pp.).—The variation in the properties of foundry castings can be attributed to several causes. Modern methods of statistical analysis which help to show the relative influence of different factors are described mathematically, and the analysis and interpretation of statistical curves is explained. The calculation of probabilities solves some of the problems of variation of properties. The application of statistical analysis to the three branches of activity on which all technical progress (particularly in aviation) depends (experimental research, engineering, and industry), is described and examples quoted.—J. L. T.

Multiple Correlation Applied to Steel-Plant Problems. W. T. Rogers (*Amer. Soc. Metals Preprint No. 27*, 1947, 16 pp.).—R. illustrates the use of multiple correlation and regression analysis in solving metallurgical problems, by considering its application to four problems encountered in steelmaking.

—R. W. R.

†**The Mathematics of Gauss.** H. Strauch, M. Hengst, P. Leinweber, J. Kammerloher, and M. Hofsäss (*Arch. Metallkunde*, 1947, **1**, (5), 201–241).—An outline, by various contributors, of the fundamentals of the mathematics of Gauss, including probable error, and its application to the statistical control of quality in industry.—E. N.

The Discoverer of Raney Nickel. Raymond B. Seymour (*Chem. Eng. News*, 1947, **25**, (37), 2628).—A brief survey of the career and discoveries of Murray Raney.—H. A. H.

Some Observations on Laboratory Planning. G. P. Contractor (*J. Sci. Indust. Research, India*, 1946, **5**, (4), 155–166; (5), 224–235; (6), 275–282).—S. R.

National Metallurgical Laboratory for India. — (*Refractories J.*, 1947, **23**, (1), 5–6).—Cf. *Met. Abs.*, 1947, **14**, 289.—P. L.

British Non-Ferrous Metals Research Association. Recent Developments in Research Activities. W. L. Hall (*Metallurgia*, 1947, **36**, (215), 257–259).

Fulmer Research Institute. — (*Engineer*, 1947, **184**, (4772), 37–39).—A general description is given of the laboratory.—R. GR.

The Fulmer Research Institute. — (*Engineering*, 1947, **164**, (4250), 43).—A short account of the Institute.—R. GR.

Fulmer Research Institute Inaugurated. — (*Light Metals*, 1947, 10, (115), 381-384).—Cf. *Met. Abs.*, this vol., p. 218. An account of the opening of the Fulmer Research Institute by Sir Stafford Cripps on 2 July 1947.

—F. A. F.

Research Progress at Midwest Research Institute. — (*Chem. Eng. News*, 1947, 25, (47), 3498-3502).—The research programme of the Institute includes work on the following subjects: cleaning compounds for non-ferrous metals, the fundamental aspects of impact loads, housing insulation with special reference to the pre-fabricated aluminium house, the corrosion of domestic water-heater tanks, the reclamation of ferrous and non-ferrous metals, and studies of the behaviour of metals under strain.—H. A. H.

Developments in Metallurgy at Birmingham University. L. Aitchison (*J. B'ham. Met. Soc.*, 1947, 27, (2), 281-295; discussion, 295-307).—A. gives the reasons for the decision to divide the Department of Metallurgy at Birmingham University into two sections, a School of Theoretical Metallurgy and a School of Industrial Metallurgy, and describes the aims of, and training provided by, the latter. He emphasizes the need, in students about to enter industry, of a knowledge of the fundamentals of industrial organization and administration. Instruction in this subject is provided in the curriculum of the school, which also covers the basic principles of the working and casting of metals. The school is, in addition, carrying out research into various industrial problems.

—R. W. R.

The Effect of Atomic Energy on Scientific and Technical Publications. R. E. Peierls (*Engineering*, 1947, 164, (4261), 305; (4262), 318).—P. discusses the effects of the Official Secrets Act and the Atomic Energy Act on discussion and publication of scientific work. He considers that, at present, the practical effects of the secrecy clause of the Atomic Energy Act are negligible, owing to the release of information under the Exemption Order.

—R. GR.

National Responsibility for Research. J. E. Graf (*Ann. Rep. Smithsonian Inst.*, 1946, 411-424).—S. G.

***Effects of Metals on Giemsa Stain Solutions in Fifty Per Cent. Glycerol and Methanol Mixtures.** R. D. Lillie (*J. Lab. Clin. Med.*, 1946, 31, 253-256; *C. Abs.*, 1946, 40, (8), 2271).—Relatively active metals of the electrolytic series have the property of decomposing thiazine eosinates in glycerol-methyl alcohol solution and removing the eosin from those solutions. Alkaline earth metals appear to act purely as alkalis. Zinc acts on methyl thionines in glycerol-methyl alcohol solution, but not on thionine, to shift their spectral absorption bands towards the red. Results show that the use of tin foils and other foils containing zinc, tin, or cadmium for lining screw caps for Giemsa stain is inadvisable. Copper foils containing appreciable amounts of zinc or tin seem to be undesirable. Paraffined cardboard seems to be the most innocuous and generally satisfactory lining material for such caps.

XXIV.—BIBLIOGRAPHY

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[The papers and discussions in this volume were presented at the Thirteenth and Seventeenth Sessions of the Forty-Ninth Annual Meeting of the A.S.T.M. held in June 1946. The papers included are: N. L. Mochel, "Introduction" (*Met. Abs.*, this vol., p. 266); Howard C. Cross and Ward F. Simmons, "Heat-Resisting Metals for Gas-Turbine Parts" (*Met. Abs.*, this vol., p. 184); J. W. Freeman, E. E. Reynolds, and A. E.

- White, "High-Temperature Alloys Developed for Aircraft Turbo-Superchargers and Gas Turbines" (*Met. Abs.*, this vol., p. 266); Robert M. Parke and Frederick P. Bens, "Chromium-Base Alloys" (*Met. Abs.*, this vol., p. 267); F. S. Badger, Jr., and W. O. Sweeny, Jr., "Metallurgy of High-Temperature Alloys Used on Current Gas-Turbine Designs" (*Met. Abs.*, this vol., p. 267); Howard C. Cross, "Alloys and Ceramic Materials for High-Temperature Service" (*Met. Abs.*, this vol., p. 268); Anton de S. Brasunas, James T. Gow, and Oscar E. Harder, "Resistance of Iron-Nickel-Chromium Alloys to Corrosion in Air at 1600° to 2200° F." (*Met. Abs.*, this vol., p. 281); Alan E. Flanigan, Leslie F. Tedsen, and John E. Dorn, "Compressive Properties of Aluminium Alloy Sheet at Elevated Temperatures" (*Met. Abs.*, this vol., p. 268); A. A. Moore and J. C. McDonald, "Tensile and Creep Strengths of Some Magnesium-Base Alloys at Elevated Temperature" (*Met. Abs.*, this vol., p. 268).]
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- ***British Intelligence Objectives Sub-Committee.** *A General Survey of the German Non-Ferrous Industry.* (Final Report No. 1660. Item No. 21.) [Mimeographed.] Cr. 4to. Pp. 51, with diagrams. 1948. London: H.M. Stationery Office. (5s. 2d., post free.)
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- ***Maréchal, Jean.** *Les Métaux et Alliages (Traité de Métallographie).* 24.5 × 16 cm. Pp. 303, with 127 illustrations. 1945. Liège: Soledi Ste. Coop.; Paris: Hermann.
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- ***Schwarzkopf, Paul,** in collaboration with C. G. Goetzel, George Stern, Robert Steinitz, and Werner Leszynski. *Powder Metallurgy: its Physics and Production.* Med. 8vo. Pp. xiii + 379, with 164 illustrations. 1947. New York: Macmillan Co. (\$8.00); London: Macmillan and Co., Ltd. (40s. net).
- ***Silman, H.** *Chemical and Electroplated Finishes: The Protective Treatment of Metals.* With a foreword by H. Moore. Demy 8vo. Pp. xiii + 414, with 131 illustrations. 1948. London: Chapman and Hall, Ltd. (30s. net.)
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- [Contents: P. R. Shepler, "Explosive Impact Tests"; A. Sniderman, "Criterion of Static and Fatigue Failures"; W. M. Claflin, "The Experimental Determination of the Dynamic Structural Response of an Airplane to Impact Loadings"; W. P. Welch, "A Proposed New Shock Measuring Instrument"; C. H. Hoepfner, "Radio Pulse Telemetering"; A. Boodberg and E. D. Howe, "Method of Obtaining the Stress at the Mid-Thickness by Measurements from Only One Surface of a Plate"; A. G. H. Dietz and W. H. Campbell, "Bonded Wire Strain-Gauge Techniques for Polymethyl Methacrylate Plastics"; W. J. Eney, Discussion on the paper by Dietz and Campbell; J. R. Stitt, "Effect of Temperature Gradients upon the Introduction of Residual Stresses in Weldments or Other Structures"; J. T. Norton and D. Rosenthal, "Recent Contributions to the X-Ray Method in the Field of Stress Analysis"; E. G. Fischer, "Lateral Vibration and Stress in a Beam Under Shock Machine Loading"; S. S. Manson, R. H. Kemp, and W. C. Morgan, "High-Temperature Strain-Gauges and their Application to Measurement of Vibratory Stresses in Turbo-Supercharger Buckets"; I. Vigness, "Some Characteristics of Navy 'High Impact' Type Shock Machines"; L. L. Rauch, "Electronic Commutation of Strain-Gauges for Telemetering"; A. H. Pedersen and J. G. MacCarthy, "Determination of the Effect of Ground Impact Forces in the Airplane Drop-Test."]
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- Wrazej, J. W.** *Metale w Przemysle.* (Biblioteczka Rzemieślnicza Lwowskiego Towarzystwa Kursów Technicznych. Tom 2.) 8vo. Pp. 160, illustrated. 1946. London: Polish Technical Publishing Trust.
- ***von Zeerleder, Alfred.** *Technologie der Leichtmetalle.* 22 × 15.5 cm. Pp. xii + 364, with 396 illustrations and 62 tables. 1947. Zürich: Rascher Verlag. (Leinen, Swiss fr. 36; brosch., Swiss fr. 32.)
- Zimmerman, O. T., and I. Lavine.** *Handbook of Material Trade Names.* 8vo. Pp. xi + 503. 1946. Dover, New Hampshire: Industrial Research Service. (45s.)

NEW PERIODICALS

Aluminium Development Association Research Reports. Each report will be a survey of a series of investigations on a particular property of light metals and alloys. Published (irregularly) by the Association, 33 Grosvenor St., London, W.1. Research Report No. 1 appeared in December 1947. (Gratis.)

Journal of the Electrochemical Society. Replaces the *Bulletin of the Electrochemical Society* and the *Electrochemical Society Preprints*. The *Transactions* will still be available. Published monthly by the Society, Mt. Royal and Guilford Aves., Baltimore 2, Md., U.S.A. First issue, vol. 93, no. 1, appeared in January 1948. (\$7.50 to members; \$10.00 to non-members, per annum.)

XXV.—BOOK REVIEWS

Werkstoffbegriffe: Eine Erläuterung werkstofftechnischer Begriffe zum Gebrauche an technischen Mittelschulen und zum Selbststudium. Herausgegeben von Hermann Christen. Dritte, durchgesehene Auflage. 20.5 × 15 cm. Pp. 197, with 174 illustrations (including 28 plates). 1947. Frauenfeld, Switzerland: Verlag Huber and Co. A.G. (Einzelpreis 6.60 sch. Swiss fr. 7.50; Schulpreis geb. Swiss fr. 6.)

This is a really first-rate little book which provides those able to read German with an excellent introduction to physical and mechanical metallurgy. Written by one with teaching experience, it is clear, concise, and very well illustrated. Using only the simplest mathematics, it yet succeeds in introducing a general mathematical atmosphere.

Divided into three sections, the monograph starts with a consideration of the whole field of mechanical testing, and the accounts of fatigue and creep are much fuller than one usually finds in such an introduction. The diagrams, here as elsewhere, are first-rate. The second part is devoted to a discussion of physical properties and of crystal structure. Part III is more technological and discusses casting structures, corrosion, which is again especially well done, thermal equilibrium diagrams, working, and recrystallization. Twenty-eight plates of macro- and microstructures are superlatively good. The references to other work will be of value to students with access to German and Swiss literature, but the author completely disregards anything ever done elsewhere.

An English translation of this small book would be of use to many students, but as it is, it affords an almost ideal text for those wishing to acquire some familiarity with metallurgical German.

On re-reading all this, the praise sounds almost fulsome, but it is a really very good little book.—F. C. THOMPSON.

Century of Silver, 1847-1947: Connecticut Yankees and a Noble Metal. By Earl Chapin May. Demy 8vo. Pp. ix + 388, with 40 plates. 1947. New York: Robert M. McBride and Co. (\$3.50.)

This is a record, written by an American journalist who has specialized in industrial histories, of the formation and growth of the International Silver Company, of Connecticut; and in a broader sense is a sketch of the history of the silverware industry of New England. The origins of the industry are traced to the groups of craftsmen who began making small quantities of pewter kitchen utensils in the small town of Meriden in 1808 and later, around 1825, turned to the production of Britannia ware. In 1847, Asa and Simeon Rogers set up a small silver electroplating shop, using the methods of the Elkington patent of 1840; and in the same year Horace Cornwall Wilcox, the father of G. H. Wilcox, one of the founders (in 1879) of the International Silver Company and its first Chairman, started trading as a pedlar on the New Haven-Hartford turnpike. In a series of sketches, sometimes imaginatively dramatized, sometimes reading as a flat transcript from the old files of local small-town newspapers, the author traces from the association of these men the growth of the sterling silver and electroplated hollow-ware and flat-ware industry in Meriden, Waterbury, Wallingford, and the surrounding New England towns, and the consolidation of many of the small concerns into the International Silver Company. Throughout the book, the emphasis is on personalities rather than on processes. None of the plants is described, and there is only the briefest of references to the tools or technical practices of the craft.

The absence of a connected narrative makes for some confusion and the book is at times overburdened with the trivia of a company house journal. The early portions of the book are the best, and in these the author contrives to present an interesting picture of life in New England a hundred years ago.—J. C. CHASTON.

Elasticity in Engineering. By F. K. van Iterson. Med. 8vo. Pp. ix + 174, with 136 illustrations. 1947. London and Glasgow: Blackie and Son, Ltd. (8s. 6d. net.)

One of the most significant of recent tendencies in the boundary zone between metallurgy and engineering is the great increase of interest now being taken in the fundamentals of the behaviour of metals under stresses exceeding the elastic limit. To metallurgist and engineer alike plasticity is a matter of prime importance.

The one factor more than any other which has retarded most metallurgists' acquaintance with the subject is the all too heavy demand made by some writers in this field on their mathematical equipment. It is with particular pleasure, therefore, that the reviewer can recommend as latest addition to the literature on the subject, one which does not pre-suppose more mathematical ability than a well-trained metallurgist may reasonably be expected to possess. No one concerned with the theoretical background of the mechanical testing or the fabrication of metals can fail to find this book really stimulating.

Whether there will be the same unanimity in accepting the author's conclusions is, however, quite a different matter. As one example of direct metallurgical interest, mention may be made of the treatment of the Brinell test. Fig. 85, which illustrates the author's views regarding the "plastified"—his own expression—region underneath the ball, is by no means consistent with the results of Sauveur's work, for instance, on the location of the regions of large grain-size obtained by indenting a dead-mild steel and then annealing it.

Again, on p. 113 it is stated that "when the elastic limit is passed and all the elements shorten and widen, there can be no question of slip planes. Particles in one horizontal layer penetrate to an underlying layer." A diagram is in fact given to press this point home. To the metallographer, it is to say the least of it difficult to accept such a statement. One reason for this may well be that much of the experimental work on which the whole treatment of the subject is based was carried out on clays. It is but fair, however, to point out that the author himself appreciates this, and says on p. 124 "for materials which harden considerably on cold working, or law of plastic flow, stating that two principal stresses are equal, fails".

Here and there one finds some slight infelicities of expression, but rarely, if ever, enough to obscure the real meaning.

Despite any differences of opinion there may be, however, there can be no doubt that this is a contribution of real value to a fascinating subject, and a book which can be recommended whole-heartedly.—F. C. THOMPSON.

Spektrochemische Betriebsanalyse: Praktische Ratschläge für die Ausföhrung spektrochemischer Analysen im Betriebslaboratorium. (Die chemische Analyse, Band 43.) By Heinrich Moritz. 24.5 × 16 cm. Pp. xi + 170, with 46 illustrations, 1946. Stuttgart: Ferdinand Enke. (geh., RM. 17; geb., RM. 18.50.)

This concise text-book deals almost entirely with metallurgical spectrochemical analysis, though some methods for non-metals are given. About one-third of it describes apparatus and light-sources of German origin; the next third on methods of analysis is of wider application; and after a short section on segregation analysis the book finishes with selected standard methods of analysis and a *bibliography*. The list of references, though largely Continental, is useful as a review of German publications from 1935 to 1945.

The methods described are based on familiar principles, but the emphasis placed on the value of step-wedges in plate calibration is probably the one thing British workers could usefully learn from Continental practice. The standard conditions described for aluminium, lead, copper, and zinc cover much the same ground as work published by the British Non-Ferrous Metals Research Association. The author states that in the control laboratory of the copper and brass works where he is employed, about three-quarters of all the analysis, including that of non-metals, was carried out spectrochemically. Only in the aluminium industry is this action likely to be exceeded.—E. VAN SOMEREN.

The Elements of Fuel Technology. By Godfrey W. Himus. Roy. 8vo. Pp. xvi + 506, with 113 illustrations. 1947. London: Leonard Hill, Ltd., 17 Stratford Place, W.1. (42s.)

Students, fuel technologists, and all connected with the preparation, combustion, and utilization of solid, liquid, or gaseous fuels will find this book a valuable addition to the literature on the subject. Very rightly, no claim has been made for it as an encyclopædia of fuel knowledge, but the extremely wide field of fuel utilization which has been covered—from blast-

furnace coke to domestic heating and cooking—makes it a very useful and compact introduction to most of the problems likely to be encountered. As in all works of such a general nature, there are points at which it is felt that the treatment of the subject has suffered for the sake of covering a wide field. The author is to be congratulated on the very small number of such instances. Where it is felt that a section has been somewhat scant, as for example in the case of gas producers, which appears to be confined to the products of one firm, the reason is felt to be more one of opinion on the best method of presentation.

The few printing errors include $H = s\delta T$ instead of $s\delta T/T$ on p. 183, "or" instead of "of" on p. 280, and +73810 in (ii) on p. 293 instead of -73810.

The subject has been treated in a logical and interesting manner, and the emphasis on such subjects as steam raising and utilization, low-temperature carbonization, the manufacture of liquid fuels from coal, and the flow of heat in furnaces, has not been laid at the expense of the general high level of the book. Whether a slight delay in publication which could have been used to insert post-war figures in the many cost calculations would have been justified is a matter of opinion. Technicians striving to burn "best" post-war coal will examine the analysis tables on pp. 42-46 with some grim amusement at such figures as 1% as the ash content of a coal.

The volume is attractively bound and illustrated with line drawings, and the *bibliographies* and index are of real value.—D. W. HOPKINS.

Technologie der Leichtmetalle. By Alfred von Zeerleder. 22 × 15.5 cm. Pp. xii + 364, with 396 illustrations and 62 tables. 1947. Zürich: Rascher Verlag. (Leinen, Swiss fr. 36; brosch., Swiss fr. 32.)

Dr. von Zeerleder, Director of Research at Neuhausen of the Aluminium Industrie, A.G., Chippis (the Swiss aluminium producers), has completely rewritten his previous treatise on the Technology of Aluminium and its Light Alloys, which ran to four German and one English editions, in order to bring it thoroughly up to date, and has included in the present work consideration of magnesium. The scope is of similar comprehensiveness to the previous work and includes a chapter on the history of the metals and their reduction, followed by more detailed treatments in ensuing chapters of the metallurgy and technology of the two light metals and their alloys, dealing with both the semi-fabrication and the final manufacturing stages.

The chapters cover Production, Alloys, Properties and Testing, Design in the Light Metals, Melting Furnaces, Casting, Rolling, Extrusion, Forging, Drawing, Wire Manufacture, Manufacture of Hollow-Ware, Thermal Processes, Machining, Welding, Riveting, Surface Treatments, Conclusion, and an up-to-date *bibliography*. Many graphs are included in the illustrations, and these and the tables in the book in most cases present original numerical data. The book is written from the viewpoint of practice, while theory, which does not go finer than the atomic, is drawn on only as a pointer to practice. An English edition is in course of preparation and is expected to appear in print this year, in which the Swiss alloy nomenclature will be amplified by some co-reference to British nomenclature, and by the addition of alloy chemical symbols which will facilitate the comprehension; also the metric quantity units will be converted to British.—A. J. FIELD.

Text-Book of the Materials of Engineering. By Herbert F. Moore. With a chapter on Concrete by Harrison F. Gonnerman, a chapter on Crystalline Structure of Metals by Jasper O. Draffin, and a chapter on Plastics. Seventh edition. Med. 8vo. Pp. x + 500, with 151 illustrations. 1947. New York: McGraw-Hill Book Co., Inc. (\$6.00); London: McGraw-Hill Publishing Co., Ltd. (30s.).

A book which was first published in 1917, and of which thirty years later a seventh edition is required, is clearly of no ordinary merit.

It deals in a descriptive and strictly non-mathematical manner with the materials, metallic and non-metallic, which the engineer employs as parts subject to stress. On the whole, the appeal seems to be rather to the engineer who wishes to know more of such materials than to the metallurgist, though as a general outline it may be found useful to many, since a vast amount of exact and up-to-date information on the widest range of subjects is to be found.

As an Appendix, extending to eight pages, a list is given of films available in America which deal with the subject matter of the book and the *forty-two* sources from which such films may be obtained. "Many Universities have large film libraries" is a statement which will almost surely find favour with teachers in this country with envy.

Each chapter is concluded by a list of references for further study, but that after the introductory Chapter I will come as an absolute stunning surprise. It is to the three stories, "The Bridge Builders", "The Ship that Found Herself", and "Bread upon the Waters" from Kipling's "The Day's Work". Only a born teacher would ever have even thought of so departing from all established academic tradition, much less have dared so to do.

—F. C. THOMPSON.